

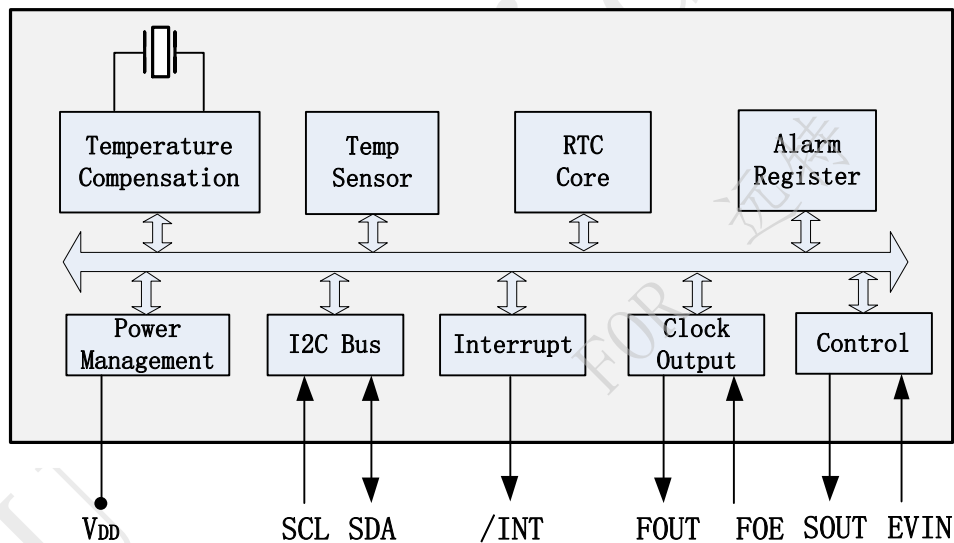


# INS5A8804—Automotive High Accuracy I<sup>2</sup>C RTC

## Key Features

- Low current consumption: 1.8uA (Typ.)
- High stability:
  - ±5ppm @ -40°C~+90°C
  - ±20ppm@ +90°C~+105°C
- Build-in TCXO: 32.768KHz
- Build-in temperature sensor
- Communication Interface: I<sup>2</sup>C bus
- Power Supply Voltage:1.6V~5.5V
- Operation Temperature Range: -40°C~+105°C
- Leap years autocorrection
- Time stamp trigger function
- Timer output function with adjustable period
- Package: 3.2mm × 2.5mm × 0.9mm
- AEC-Q100 Compliant
- RoHS2.0 & REACH compliant

## Block Diagram



## Overview

INS5A8804 is a high-accuracy I<sup>2</sup>C bus interface real-time clock with low power consumption. It embeds a 32.768KHz TCXO. The high precise temperature sensor and temperature compensated circuit ensure the high clock accuracy. It supports calendar (year, month, day, hour, minute, second), clock and timer functions etc. The SMD3225 package with only 0.9mm thickness and AEC-Q100 compliant makes it suitable for automotive applications.



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# 1 Overview

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# 2 Block Diagram

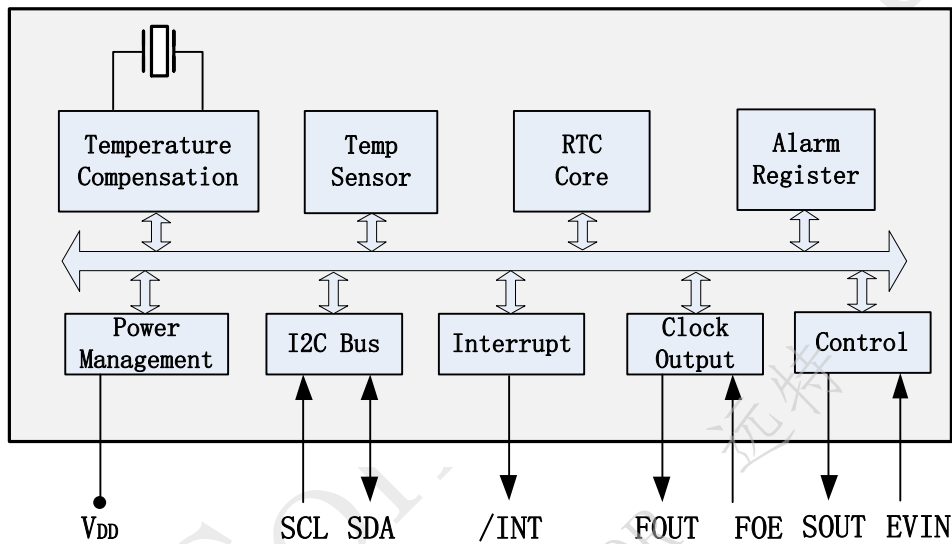


Figure 1. Block Diagram

# 3 Features

- Low current consumption: 1.8uA (Typ.)
- High stability:
  - ±5ppm @ -40°C~+90°C
  - ±20ppm@ +90°C~ +105°C
- Communication Interface: I2C bus
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- Package: 3.2mm × 2.5mm × 0.9mm
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## 4 Pin definition



**Table1. Pin Definition**

| Pin Number | Pin Name        | I/O    | Description   |
|------------|-----------------|--------|---|
| 1          | FOE             | In     | FOUT output control pin. “1”- enable FOUT, “0”-FOUT Hi-Z, build-in pull down resistor(Typ:500K Ω).                        |
| 2          | V <sub>DD</sub> | -      | Power supply  |
| 3          | EVIN            | In     | Trigger input terminal for time stamps.   |
| 4          | FOUT            | Out    | Frequency output. Controlled by FOE. Frequency can be set by FSEL bits.   |
| 5          | SCL             | In     | I <sup>2</sup> C clock signal   |
| 6          | SOUT            | Out    | SOUT is the inside state output (CMOS output).<br>SOUT outputs state of a specified flag bit or programmed logical 1 or 0 |
| 7          | SDA             | In/Out | I <sup>2</sup> C data signal  |
| 8          | NC              | -      |   |
| 9          | GND             | -      | Ground  |
| 10         | /INT            | Out    | Interrupt Output, Open-Drain  |



## 5 Electrical Characteristics

### 5.1 Absolute Maximum Ratings

**Table2. Absolute Maximum Ratings**

| Parameter            | Symbol            | Value   |      |                      | Unit | Notes               |
|----------------------|-------------------|---------|------|----------------------|------|---------------------|
|                      |                   | Min.    | Typ. | Max.                 |      |                     |
| Power Supply Voltage | V <sub>DD</sub>   | -0.3    |      | 6.5                  | V    |                     |
| Input Voltage        | V <sub>IN</sub>   | GND-0.3 |      | 6.5                  | V    | FOE, SCL, SDA, EVIN |
| Output Voltage       | V <sub>OUT1</sub> | GND-0.3 |      | V <sub>DD</sub> +0.3 | V    | FOUT, SOUT          |
|                      | V <sub>OUT2</sub> | GND-0.3 |      | 6.5                  | V    | SDA, /INT           |
| Storage temperature  | T <sub>STG</sub>  | -55     |      | 125                  | °C   |                     |

### 5.2 Recommended Operating Conditions

**Table3. Recommended Operating Conditions**

| Parameter             | Symbol           | Value |      |      | Unit | Notes         |
|-----------------------|------------------|-------|------|------|------|---------------|
|                       |                  | Min.  | Typ. | Max. |      |               |
| Power Supply Voltage  | V <sub>DD</sub>  | 1.6   | 3.0  | 5.5  | V    |               |
| Current consumption   | I <sub>DD</sub>  |       | 1.8  |      | uA   | @25°C, VDD=3V |
| Operation temperature | T <sub>OPR</sub> | -40   | 25   | 105  | °C   |               |

Note 1: During the power on and oscillation starting time, a voltage of more than 2.5V must be provided to ensure the oscillation circuit to a stable state.

Note2: After the power supply is removed or power off, ensure that VDD=GND for more than 10 seconds before next power on cycle.

Note3: If there is no special indication, the test conditions are GND =0V, VDD=1.6V~5.5V, Ta=-40°C~+105°C

### 5.3 Frequency Characteristics

**Table4. Frequency Characteristics**

| Parameter              | Symbol           | Value |      |      | Unit | Notes             |
|------------------------|------------------|-------|------|------|------|-------------------|
|                        |                  | Min.  | Typ. | Max. |      |                   |
| Frequency stability    | Δf/f             | -5    |      | +5   | ppm  | -40°C~+90°C       |
| Frequency stability    | Δf/f             | -20   |      | +20  | ppm  | +90°C~+105°C      |
| Oscillation start time | t <sub>STA</sub> |       |      | 1    | s    | @25°C, VDD=3V     |
| Year Aging             | f <sub>a</sub>   | -5    |      | +5   | ppm  | @25°C, First year |
| FOUT duty cycle        | t <sub>w/t</sub> | 40    | 50   | 60   | %    |                   |



## 5.4 DC Characteristics

**Table5. DC Characteristics**

| Parameter                    | Symbol            | Value               |      |                     | Unit | Notes   |   |
|------------------------------|-------------------|---------------------|------|---------------------|------|---|---|
|                              |                   | Min.                | Typ. | Max.                |      |   |   |
| Average Current consumption1 | I <sub>DD1</sub>  |                     | 1.9  | 26                  | uA   | V <sub>DD</sub> =5.0V                           | f <sub>SCL</sub> =0Hz, FOE=GND, /INT = V <sub>DD</sub> ; FOUT off (High-Z); Compensation interval 2s;                   |
| Average Current consumption2 | I <sub>DD2</sub>  |                     | 1.8  | 25                  |      | V <sub>DD</sub> =3.0V                           |   |
| Average Current consumption3 | I <sub>DD3</sub>  |                     | 4.8  | 30                  | uA   | V <sub>DD</sub> =5.0V                           | f <sub>SCL</sub> =0Hz, FOE=V <sub>DD</sub> , /INT = V <sub>DD</sub> ; FOUT:32.768kHz, CL=0pF; Compensation interval 2s; |
| Average Current consumption4 | I <sub>DD4</sub>  |                     | 2.8  | 28                  |      | V <sub>DD</sub> =3.0V                           |   |
| Average Current consumption5 | I <sub>DD5</sub>  |                     | 10   | 35                  | uA   | V <sub>DD</sub> =5.0V                           | f <sub>SCL</sub> =0Hz, / INT = Hi-Z, FOUT outputs 32 kHz, CL = 30 pF, Temp compensation interval 2.0 s                  |
| Average Current consumption6 | I <sub>DD6</sub>  |                     | 6    | 28                  |      | V <sub>DD</sub> =3.0V                           |   |
| Average Current consumption7 | I <sub>DD7</sub>  |                     | 1.85 | 24                  | uA   | V <sub>DD</sub> =5.0V                           | f <sub>SCL</sub> =0Hz, / INT = Hi-Z, FOUT is stopped, Temp compensation is stopped.                                     |
| Average Current consumption8 | I <sub>DD8</sub>  |                     | 1.75 | 23                  |      | V <sub>DD</sub> =3.0V                           |   |
| Peak Current consumption (1) | I <sub>DD9</sub>  |                     | 55   | 95                  | uA   | V <sub>DD</sub> =5.0V                           | f <sub>SCL</sub> =0Hz, / INT = V <sub>DD</sub> , FOUT is stopped, Temp compensation ON (peak)                           |
| Peak Current consumption (2) | I <sub>DD10</sub> |                     | 50   | 90                  |      | V <sub>DD</sub> =3.0V                           |   |
| Low Voltage Detection        | V <sub>LF</sub>   | 1                   | 1.3  | 1.5                 | V    |   |   |
| High-level input voltage     | V <sub>IH</sub>   | 0.8*V <sub>DD</sub> |      | V <sub>DD</sub>     | V    | SCL, SDA, FOE, EVIN                             |   |
| Low-level input voltage      | V <sub>IL</sub>   | GND-0.3             |      | 0.2*V <sub>DD</sub> | V    |   |   |
| High-level output voltage    | V <sub>OH1</sub>  | 4.0                 |      | 5.0                 | V    | V <sub>DD</sub> =5.0V, I <sub>OH</sub> = -1mA   | FOUT, SOUT  |
|                              | V <sub>OH2</sub>  | 2.2                 |      | 3.0                 |      | V <sub>DD</sub> =3.0V, I <sub>OH</sub> = -1mA   |   |
|                              | V <sub>OH3</sub>  | 2.9                 |      | 3.0                 |      | V <sub>DD</sub> =3.0V, I <sub>OH</sub> = -100uA |   |
| Low-level output voltage     | V <sub>OL1</sub>  | GND                 |      | GND+0.5             | V    | V <sub>DD</sub> =5.0V, I <sub>OL</sub> = 1mA    | FOUT, SOUT  |
|                              | V <sub>OL2</sub>  | GND                 |      | GND+0.8             |      | V <sub>DD</sub> =3.0V, I <sub>OL</sub> = 1mA    |   |
|                              | V <sub>OL3</sub>  | GND                 |      | GND+0.1             |      | V <sub>DD</sub> =3.0V, I <sub>OL</sub> = 100uA  |   |
|                              | V <sub>OL4</sub>  | GND                 |      | GND+0.25            |      | V <sub>DD</sub> =5.0V, I <sub>OL</sub> = 1mA    |   |



| Parameter              | Symbol           | Value |      |         | Unit | Notes   |
|------------------------|------------------|-------|------|---------|------|---|
|                        |                  | Min.  | Typ. | Max.    |      |   |
|                        | V <sub>OL5</sub> | GND   |      | GND+0.4 | V    | V <sub>DD</sub> =3.0V, I <sub>OL</sub> = 1mA /INT               |
|                        | V <sub>OL6</sub> | GND   |      | GND+0.4 | V    | V <sub>DD</sub> ≥3.0V, I <sub>OL</sub> = 3mA SDA                |
| Input leakage current  | I <sub>LK</sub>  | -0.5  |      | 0.5     | uA   | FOE, SDA, SCL, EVIN, V <sub>IN</sub> = V <sub>DD</sub> or GND   |
| Output leakage current | I <sub>oz</sub>  | -0.5  |      | 0.5     | uA   | FOUT, SDA, /INT, SOUT, V <sub>IN</sub> = V <sub>DD</sub> or GND |

Note: If there is no special indication, the test conditions are GND=0V, VDD=1.6V~5.5V, Ta=-40°C~+105°C.

## 5.5 AC Characteristics

**Table6. AC Characteristics**

| Parameter  | Symbol              | Value |      |      | Unit |
|--|---------------------|-------|------|------|------|
|  |                     | Min.  | Typ. | Max. |      |
| SCL clock frequency                                      | f <sub>SCL</sub>    |       |      | 400  | kHz  |
| SCL low level time                                       | t <sub>LOW</sub>    | 1.3   |      |      | us   |
| SCL high level time                                      | t <sub>HIGH</sub>   | 0.6   |      |      | us   |
| Start condition setup time                               | t <sub>HD:STA</sub> | 0.6   |      |      | us   |
| Start condition hold time                                | t <sub>SU:STA</sub> | 0.6   |      |      | us   |
| Stop condition setup time                                | t <sub>SU:STO</sub> | 0.6   |      |      | us   |
| Bus idle time between start condition and stop condition | t <sub>RCV</sub>    | 1.3   |      |      | us   |
| Data setup time  | t <sub>SU:DAT</sub> | 100   |      |      | ns   |
| Data hold time   | t <sub>HD:DAT</sub> | 0     |      |      | us   |
| SCL, SDA rising time                                     | t <sub>r</sub>      |       |      | 0.3  | us   |
| SCL, SDA falling time                                    | t <sub>f</sub>      |       |      | 0.3  | us   |

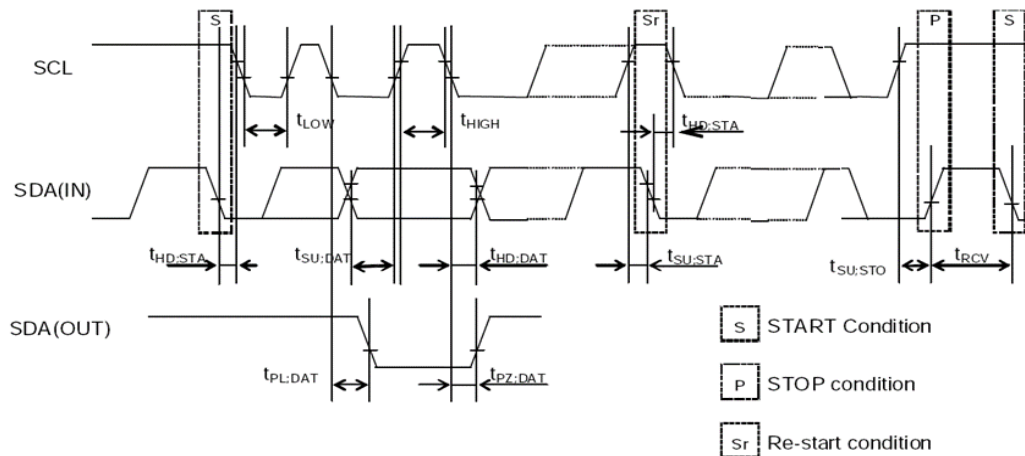


Figure 2. I<sup>2</sup>C bus Timing Chart





Note: when the master equipment accesses the equipment through I2C bus, all communication from sending start condition to sending stop shall be completed within 1 second. If it exceeds 1 second, the I2C bus interface will be reset through the internal bus timeout function.

## 6 Registers

### 6.1 Register Lists

Address 0x00~0x0F: Basic Time and Calendar Registers

Address 0x10~0x1F: Extended Registers

Address 0x20: ID Registers

**Table7. Basic Time and Calendar Registers**

| Address | Function        | bit7                  | bit6                    | bit5                  | bit4                   | bit3                     | bit2        | bit1        | bit0        | R/W |
|---------|-----------------|-----------------------|-------------------------|-----------------------|------------------------|--------------------------|-------------|-------------|-------------|-----|
| 0x00    | SEC             | ○                     | Second ten's place, 0-5 |                       |                        | Second unit's place, 0-9 |             |             |             | R/W |
| 0x01    | MIN             | ○                     | Minute ten's place, 0-5 |                       |                        | Minute unit's place, 0-9 |             |             |             | R/W |
| 0x02    | HOUR            | ○                     | ○                       | Hour ten's place, 0-2 |                        | Hour unit's place, 0-9   |             |             |             | R/W |
| 0x03    | WEEK            | ○                     | 6                       | 5                     | 4                      | 3                        | 2           | 1           | 0           | R/W |
| 0x04    | DAY             | ○                     | ○                       | Day ten's place, 0-3  |                        | Day unit's place, 0-9    |             |             |             | R/W |
| 0x05    | MONTH           | ○                     | ○                       | ○                     | Month ten's place, 0-1 | Month unit's place, 0-9  |             |             |             | R/W |
| 0x06    | YEAR            | Year ten's place, 0-9 |                         |                       |                        | Year unit's place, 0-9   |             |             |             | R/W |
| 0x07    | RAM             | ●                     | ●                       | ●                     | ●                      | ●                        | ●           | ●           | ●           | R/W |
| 0x08    | MIN Alarm       | AE                    | Minute ten's place, 0-5 |                       |                        | Minute unit's place, 0-9 |             |             |             | R/W |
| 0x09    | HOUR Alarm      | AE                    | ●                       | Hour ten's place, 0-2 |                        | Hour unit's place, 0-9   |             |             |             | R/W |
| 0x0A    | WEEK Alarm      | AE                    | 6                       | 5                     | 4                      | 3                        | 2           | 1           | 0           | R/W |
|         | DAY Alarm       |                       | ●                       | Day ten's place, 0-3  |                        | Day unit's place, 0-9    |             |             |             | R/W |
| 0x0B    | Timer Counter 0 | 128                   | 64                      | 32                    | 16                     | 8                        | 4           | 2           | 1           | R/W |
| 0x0C    | Timer Counter 1 | 32768                 | 16384                   | 8192                  | 4096                   | 2048                     | 1024        | 512         | 256         | R/W |
| 0x0D    | Control 1       | TEST                  | WADA                    | USEL                  | TE                     | FSEL<br>[1]              | FSEL<br>[0] | TSEL<br>[1] | TSEL<br>[0] | R/W |
| 0x0E    | Flag Register   | ○                     | ○                       | UF                    | TF                     | AF                       | ○           | VLF         | RSV         | R/W |
| 0x0F    | Control 2       | CSEL<br>[1]           | CSEL<br>[0]             | UIE                   | TIE                    | AIE                      | ○           | ○           | RESET       | R/W |


**Table8. Extended Registers**

| Address | Function         | bit7                  | bit6                    | bit5                  | bit4                   | bit3                     | bit2   | bit1   | bit0   | R/W |
|---------|------------------|-----------------------|-------------------------|-----------------------|------------------------|--------------------------|--------|--------|--------|-----|
| 0x10    | Time Stamp SEC   | ○                     | Second ten's place, 0-5 |                       |                        | Second unit's place, 0-9 |        |        |        | R   |
| 0x11    | Time Stamp MIN   | ○                     | Minute ten's place, 0-5 |                       |                        | Minute unit's place, 0-9 |        |        |        | R   |
| 0x12    | Time Stamp HOUR  | ○                     | ○                       | Hour ten's place, 0-2 |                        | Hour unit's place, 0-9   |        |        |        | R   |
| 0x13    | Time Stamp WEEK  | ○                     | 6                       | 5                     | 4                      | 3                        | 2      | 1      | 0      | R   |
| 0x14    | Time Stamp DAY   | ○                     | ○                       | Day ten's place, 0-3  |                        | Day unit's place, 0-9    |        |        |        | R   |
| 0x15    | Time Stamp MONTH | TSVLF                 | RSV                     | ○                     | Month ten's place, 0-1 | Month unit's place, 0-9  |        |        |        | R   |
| 0x16    | Time Stamp YEAR  | Year ten's place, 0-9 |                         |                       |                        | Year unit's place, 0-9   |        |        |        | R   |
| 0x17    | EVIN set         | ECP                   | EHL                     | EPU                   | RCE                    | EIE                      | ○      | ET[1]  | ET[0]  | R/W |
| 0x18    | EVIN det         | EF                    | ○                       | ○                     | ○                      | EVMON                    | ○      | ○      | ○      | R/W |
| 0x19    | SOUT config1     | SOE[7]                | SOE[6]                  | SOE[5]                | SOE[4]                 | SOE[3]                   | SOE[2] | SOE[1] | SOE[0] | R/W |
| 0x1A    | SOUT config2     | DCE                   | DC                      | ○                     | ○                      | SRV                      | FS[2]  | FS[1]  | FS[0]  | R/W |
| 0x1B    | Timer set        | TSTP                  | TRES                    | ○                     | ○                      | ○                        | ○      | ○      | ○      | R/W |
| 0x1C    | Timer0           | 128                   | 64                      | 32                    | 16                     | 8                        | 4      | 2      | 1      | R   |
| 0x1D    | Timer1           | 32768                 | 16384                   | 8192                  | 4096                   | 2048                     | 1024   | 512    | 256    | R   |
| 0x1E    | Timer2           | 8388608               | 4194304                 | 2097152               | 1048576                | 524288                   | 262144 | 131072 | 65536  | R   |
| 0x1F    | Timer counter 2  | 8388608               | 4194304                 | 2097152               | 1048576                | 524288                   | 262144 | 131072 | 65536  | R/W |

**Table9. ID Registers**

| Address | Function | bit7           | bit6 | bit5 | bit4 | bit3         | bit2 | bit1 | bit0 | R/W |
|---------|----------|----------------|------|------|------|--------------|------|------|------|-----|
| 0x20    | ID       | Vendor ID[3:0] |      |      |      | Version[3:0] |      |      |      | R   |

Note:

1, After power-up reset or in case VLF bit returns "1", make sure to initialize all registers to default state before using the RTC. Ensure all inputs



are in the required range and the defined values are set for the reserved bits in case the clock cannot work normally.

- ✓ During the initial power-up, below bits will be in the state as below:

Initial 0: TEST, WADA, USEL, TE, FSEL[1:0], TSEL[0], UF, TF, AF, EF, CSEL[1], UIE, TIE, AIE, RESET, TSVLF,  
 ECP, EHL, EPU, RCE, EIE, ET[1:0], EVMON, SOE[7:0], DCE, DC, SRV, FS[2:0], TRES, TSTP,  
 All bits of address 1Fh.

Initial 1: TSEL[1], VLF, CSEL[0], All bits of address 1Ch, 1Dh, 1Eh.

- ✓ All other register values are undefined, so make sure to reset the module before using it.
- ✓ The bits marked with “○” can be read out “0” only after initializing.
- ✓ The bits marked with “●” are RAM bits which can be used to write or read any data.
- ✓ Only 0 can be written to UF, TF, AF, VLF bits.
- ✓ Make sure “0” to be written for TEST bits which are used for testing only.
- ✓ Forbidden to modify the register except 6.1 register list and RSV register.

## 6.2 Details of Registers

### 6.2.1 Clock counter registers

| Address | Function | bit7 | bit6                              | bit5                            | bit4 | bit3                               | bit2 | bit1 | bit0 | Default |
|---------|----------|------|-----------------------------------|---------------------------------|------|------------------------------------|------|------|------|---------|
| 0x00    | SEC      | ○    | BCD code, Second ten's place, 0-5 |                                 |      | BCD code, Second unit's place, 0-9 |      |      |      | 0x00    |
| 0x01    | MIN      | ○    | BCD code, Minute ten's place, 0-5 |                                 |      | BCD code, Minute unit's place, 0-9 |      |      |      | 0x00    |
| 0x02    | HOUR     | ○    | ○                                 | BCD code, Hour ten's place, 0-2 |      | BCD code, Hour unit's place, 0-9   |      |      |      | 0x00    |

SEC: BCD format, Value: 0~59

MIN: BCD format, Value: 0~59

HOUR: BCD format, Value: 0~23

| Address | Function | bit7 | bit6 | bit5 | bit4 | bit3 | bit2 | bit1 | bit0 | Default |
|---------|----------|------|------|------|------|------|------|------|------|---------|
| 0x03    | WEEK     | ○    | 6    | 5    | 4    | 3    | 2    | 1    | 0    | 0x40    |

WEEK: Value 01h, 02h, 04h, 08h, 10h, 20h, 40h. Only one bit can be set to 1 each time, all others must be set to 0.

**Table10. WEEK Register**

| 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    |



| WEEK      | Data | bit7 | bit6 | bit5 | bit4 | bit3 | bit2 | bit1 | bit0 |
|-----------|------|------|------|------|------|------|------|------|------|
| 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    |

| Address | Function | bit7 | bit6 | bit5                           | bit4 | bit3                            | bit2 | bit1 | bit0 | Default |
|---------|----------|------|------|--------------------------------|------|---------------------------------|------|------|------|---------|
| 0x04    | DAY      | ○    | ○    | BCD code, Day ten's place, 0-3 |      | BCD code, Day unit's place, 0-9 |      |      |      | 0x01    |

DAY: BCD format, the value range will be adjusted automatically according to the month setting and if a leap year or not .

**Table11. DAY Register Value**

| Month                   | Day Value Range |
|-------------------------|-----------------|
| 1, 3, 5, 7, 8, 10, 12   | 1~31            |
| 4, 6, 9, 11             | 1~30            |
| February in normal year | 1~28            |
| February in leap year   | 1~29            |

| Address | Function | bit7                            | bit6 | bit5 | bit4                             | bit3                              | bit2 | bit1 | bit0 | Default |
|---------|----------|---------------------------------|------|------|----------------------------------|-----------------------------------|------|------|------|---------|
| 0x05    | MONTH    | ○                               | ○    | ○    | BCD code, Month ten's place, 0-1 | BCD code, Month unit's place, 0-9 |      |      |      | 0x01    |
| 0x06    | YEAR     | BCD code, Year ten's place, 0-9 |      |      |                                  | BCD code, Year unit's place, 0-9  |      |      |      | 0x00    |

MONTH: BCD format, Value1~12

YEAR: BCD format, Value0~99(2000~2099)

Example: 2020/01/01 Wednesday 21:18:36

| Address | Function | bit7 | bit6 | bit5 | bit4 | bit3 | bit2 | bit1 | bit0 |
|---------|----------|------|------|------|------|------|------|------|------|
| 0x00    | SEC      | ○    | 0    | 1    | 1    | 0    | 1    | 1    | 0    |
| 0x01    | MIN      | ○    | 0    | 0    | 1    | 1    | 0    | 0    | 0    |
| 0x02    | HOURL    | ○    | ○    | 1    | 0    | 0    | 0    | 0    | 1    |
| 0x03    | WEEK     | ○    | 0    | 0    | 0    | 1    | 0    | 0    | 0    |
| 0x04    | DAY      | ○    | ○    | 0    | 0    | 0    | 0    | 0    | 1    |
| 0x05    | MONTH    | ○    | ○    | ○    | 0    | 0    | 0    | 0    | 1    |
| 0x06    | YEAR     | 0    | 0    | 1    | 0    | 0    | 0    | 0    | 0    |



### 6.2.2 Alarm registers

| Address | Function   | bit7 | bit6                              | bit5                            | bit4 | bit3                               | bit2                            | bit1 | bit0 | Default |
|---------|------------|------|-----------------------------------|---------------------------------|------|------------------------------------|---------------------------------|------|------|---------|
| 0x08    | MIN Alarm  | AE   | BCD code, Minute ten's place, 0-5 |                                 |      | BCD code, Minute unit's place, 0-9 |                                 |      |      | 0x00    |
| 0x09    | HOUR Alarm | AE   | ●                                 | BCD code, Hour ten's place, 0-2 |      | BCD code, Minute unit's place, 0-9 |                                 |      |      | 0x00    |
| 0x0A    | WEEK Alarm | AE   | 6                                 | 5                               | 4    | 3                                  | 2                               | 1    | 0    | 0x00    |
|         | DAY Alarm  |      | ●                                 | BCD code, Day ten's place, 0-3  |      |                                    | BCD code, Day unit's place, 0-9 |      |      |         |

According to AIE, AF, WADA bits setting, the alarm interrupt will be generated once the current time match the settings in the above registers, the /INT pin goes to low level and AF bit is set to '1' to record an alarm interrupt event has occurred.

WEEK Alarm/DAY Alarm: Controlled by WADA bit in 0x0D register

AE: Alarm Enable bit, 0-enable; 1-disenable

AF: Defined in 0x0E register bit3

AIE: Defined in 0x0F register bit3

### 6.2.3 Timer control registers

| Address | Function        | bit7    | bit6    | bit5    | bit4    | bit3   | bit2   | bit1   | bit0  | Default |
|---------|-----------------|---------|---------|---------|---------|--------|--------|--------|-------|---------|
| 0x0B    | Timer Counter 0 | 128     | 64      | 32      | 16      | 8      | 4      | 2      | 1     | 0x00    |
| 0x0C    | Timer Counter 1 | 32768   | 16384   | 8192    | 4096    | 2048   | 1024   | 512    | 256   | 0x00    |
| 0x1B    | Timer set       | TSTP    | TRES    | ○       | ○       | ○      | ○      | ○      | ○     | 0x00    |
| 0x1C    | Timer0          | 128     | 64      | 32      | 16      | 8      | 4      | 2      | 1     | 0xFF    |
| 0x1D    | Timer1          | 32768   | 16384   | 8192    | 4096    | 2048   | 1024   | 512    | 256   | 0xFF    |
| 0x1E    | Timer2          | 8388608 | 4194304 | 2097152 | 1048576 | 524288 | 262144 | 131072 | 65536 | 0xFF    |
| 0x1F    | Timer Counter 2 | 8388608 | 4194304 | 2097152 | 1048576 | 524288 | 262144 | 131072 | 65536 | 0x00    |

According to TE, TF, TIE, TSEL[1:0] bits setting, a timer interrupt will be generated once the value countdowns to 0 from the one set in the above Timer Counter registers.

TE: Defined in 0x0D register bit4

TF: Defined in 0x0E register bit4



TIE: Defined in 0x0F register bit4

TSEL[1:0]:Defined in 0x0D register bit1 and bit0

TSTP: 0: Timer counter are continued

1: Stop the timer counter

TRES: Timer counter reset control

0: Timer counter do not reset

1: Timer counter reset to default value

### 6.2.4 Control registers 1

| Address | Function  | bit7 | bit6 | bit5 | bit4 | bit3    | bit2    | bit1    | bit0    | Default |
|---------|-----------|------|------|------|------|---------|---------|---------|---------|---------|
| 0x0D    | Control 1 | TEST | WADA | USEL | TE   | FSEL[1] | FSEL[0] | TSEL[1] | TSEL[0] | 0x02    |

TEST: Test bit, must be set to “0”

WADA: WeekAlarm/ DayAlarm control bit, decide 0x0A register as DAY Alarm or WEEK Alarm. 0-WEEK alarm, 1-DAY alarm

USEL: Update Interrupt Select bit, 0-output interrupt once a second, 1-output interrupt once a minute

TE: Timer Enable bit, 0-disable, 1-enable

FSEL[1], FSEL[0]:FOUT frequency setting:

| FSEL[1] | FSEL[0] | FOUT Frequency     |
|---------|---------|--------------------|
| 0       | 0       | 32.768KHz(Default) |
| 0       | 1       | 1024Hz             |
| 1       | 0       | 1Hz                |
| 1       | 1       | 32.768KHz          |

TSEL[1], TSEL[0]:Timer countdown period(source clock) setting:

| TSEL[1] | TSEL[0] | Source clock |
|---------|---------|--------------|
| 0       | 0       | 4096Hz       |
| 0       | 1       | 64Hz         |
| 1       | 0       | 1Hz          |
| 1       | 1       | 1/60Hz       |

### 6.2.5 Flag registers

| Address | Function      | bit7 | bit6 | bit5 | bit4 | bit3 | bit2 | bit1 | bit0 | Default |
|---------|---------------|------|------|------|------|------|------|------|------|---------|
| 0x0E    | Flag Register | ○    | ○    | UF   | TF   | AF   | ○    | VLF  | RSV  | 0x03    |

UF: Update flag bit. When time update interrupt event occurs, it will be set to “1”and keeps“1” until a “0” is written to it.

TF: Timer Flag bit. When a fixed-cycle timer interrupt event occurs, it will be set to “1” and keeps“1” until a



“0” is written to it.

AF: Alarm Flag bit. When an alarm interrupt event occurs, it will be set to “1” and keeps “1” until a “0” is written to it.

VLF: Voltage Low Flag bit. When supply voltage is lower than 1.3V(Typ), it will be set to “1” and keeps “1” until a “0” is written to it.

## 6.2.6 Control registers 2

| Address | Function  | bit7        | bit6        | bit5 | bit4 | bit3 | bit2 | bit1 | bit0  | Default |
|---------|-----------|-------------|-------------|------|------|------|------|------|-------|---------|
| 0x0F    | Control 2 | CSEL<br>[1] | CSEL<br>[0] | UIE  | TIE  | AIE  | ○    | ○    | RESET | 0x40    |

CSEL[1], CSEL[0]: Compensation interval Select 1, 0 bits, used to set temperature compensation interval.

| CSEL[1] | CSEL[0] | Compensation interval |
|---------|---------|-----------------------|
| 0       | 0       | 0.5s                  |
| 0       | 1       | 2s(default)           |
| 1       | 0       | 10s                   |
| 1       | 1       | 30s                   |

UIE: Update Interrupt Enable bit. When UF changes from “0” to “1”, this bit controls if an interrupt signal is generated. 0-disable(/INT keeps Hi-Z), 1-enable(/INT status changes from Hi-Z to Low).

TIE: Timer Interrupt Enable bit: When TF changes from “0” to “1”, this bit controls if an interrupt signal is generated. 0-disable(/INT keeps Hi-Z), 1-enable(/INT status changes from Hi-Z to Low).

AIE: Alarm Interrupt Enable bit: When AF changes from “0” to “1”, this bit controls if an interrupt signal is generated. 0-disable(/INT keeps Hi-Z), 1-enable(/INT status changes from Hi-Z to Low).

RESET: Reset divider, prepared for the synchronized starting of time or timer.

| Reset | Value |   |
|-------|-------|---|
| Write | 0     | Write 0 is invalid  |
|       | 1     | Write 1 reset 16384Hz~1Hz of 32.768KHz counter                |
| Read  | 0     | The read value of RESET is 0, always writes 0, it is invalid. |
|       | 1     | RESET bit clears automatically after Write access.            |

The detailed function of RESET.

For example.

S is start condition. P is stop condition.

Write access to RESET bit.

S—lave address—ACK1—0Fh—ACK2—01h—ACK3—P.

After P, RESET bit clears automatically.



### 6.2.7 SOUT Control register

| Address | Function     | bit7   | bit6   | bit5   | bit4   | bit3   | bit2   | bit1   | bit0   | Default |
|---------|--------------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| 0x19    | SOUT config1 | SOE[7] | SOE[6] | SOE[5] | SOE[4] | SOE[3] | SOE[2] | SOE[1] | SOE[0] | 0x00    |
| 0x1A    | SOUT config2 | DCE    | DC     | ○      | ○      | SRV    | FS[2]  | FS[1]  | FS[0]  | 0x00    |

By setting 0x19h = 0x69, SOUT function becomes activated. Other data disable SOUT function, then SOUT becomes Hi-Z.

In case of DCE = 1, DC bit value is outputted at SOUT.

In case of DCE = 0, register value Flag Value is outputted at SOUT. If SRV = 1 then SOUT output reverse. Flag Value is decided by SRV, FS[2:0].

| DCE | DC | FS[2] | FS[1] | FS[0] | Flag Value | SOUT Output |                  |
|-----|----|-------|-------|-------|------------|-------------|------------------|
|     |    |       |       |       |            | SRV = 0     | SRV = 1          |
| 0   | X  | 0     | 0     | 0     | TF         | TF          | Inversion of TF  |
| 0   | X  | 0     | 0     | 1     | AF         | AF          | Inversion of AF  |
| 0   | X  | 0     | 1     | 0     | UF         | UF          | Inversion of UF  |
| 0   | X  | 0     | 1     | 1     | EF         | EF          | Inversion of EF  |
| 0   | X  | 1     | 0     | 0     | X          | X           |                  |
| 0   | X  | 1     | 0     | 1     | VLF        | VLF         | Inversion of VLF |
| 0   | X  | 1     | 1     | 0     | -          | Low         |                  |
| 0   | X  | 1     | 1     | 1     | -          | Low         |                  |
| 1   | 0  | X     | X     | X     | X          | Low         |                  |
| 1   | 1  | X     | X     | X     | X          | High        |                  |





## 6.2.8 Time Stamp Data Event Controller register

| Address | Function         | bit7  | bit6 | bit5 | bit4 | bit3  | bit2 | bit1  | bit0  | Default |
|---------|------------------|-------|------|------|------|-------|------|-------|-------|---------|
| 0x10    | Time Stamp SEC   | ○     | 40   | 20   | 10   | 8     | 4    | 2     | 1     | 0x00    |
| 0x11    | Time Stamp MIN   | ○     | 40   | 20   | 10   | 8     | 4    | 2     | 1     | 0x00    |
| 0x12    | Time Stamp HOUR  | ○     | ○    | 20   | 10   | 8     | 4    | 2     | 1     | 0x00    |
| 0x13    | Time Stamp WEEK  | ○     | 6    | 5    | 4    | 3     | 2    | 1     | 0     | 0x00    |
| 0x14    | Time Stamp DAY   | ○     | ○    | 20   | 10   | 8     | 4    | 2     | 1     | 0x00    |
| 0x15    | Time Stamp MONTH | TSVLF | RSV  | ○    | 10   | 8     | 4    | 2     | 1     | 0x00    |
| 0x16    | Time Stamp YEAR  | 80    | 40   | 20   | 10   | 8     | 4    | 2     | 1     | 0x00    |
| 0x17    | EVIN set         | ECP   | EHL  | EPU  | RCE  | EIE   | ○    | ET[1] | ET[0] | 0x00    |
| 0x18    | EVIN det         | EF    | ○    | ○    | ○    | EVMON | ○    | ○     | ○     | 0x00    |

### 1) Time stamp SEC ~ YEAR

In case of trigger input detection from EVIN terminal, Clock and calendar data are recorded in Time stamp SEC ~ YEAR.

### 2) Time stamp VLF, Time stamp VDET

In case of trigger input detection from EVIN terminal, VLF bit is recorded to TSVLF.

### 3) ECP bit (Event capture Enable)

ECP enables Time Stamp function. Time Stamp function is enabled in case of ECP = 1.

### 4) EHL bit (EVIN pin, High/Low detection select)

Selection bit of EVIN Voltage level. In case of EHL = 0, EVIN pin detects active Low level; In case of EHL = 1, EVIN pin detects active High level.

### 5) EPU bit (Enable Pull-up register)

EPU enables Pull-up-resistor of EVIN input terminal. 0 – disabled; 1-enabled.

### 6) RCE bit (Repeat Capture Enable)

RCE enables repeated times stamp capture. 0 – disabled; 1-enabled.



7) EF bit (Event trigger Flag)

History bit of EVIN trigger. 0 – There is no EVIN detection history; 1- There is EVIN detection history.

8) ET[1:0] bits (Event input debounce Time set)

Selection of debounce filtering cycle time.

| ET[1] | ET[0] | Filtering Cycle Time |
|-------|-------|----------------------|
| 0     | 0     | No filtered(default) |
| 0     | 1     | 3.9ms                |
| 1     | 0     | 15.6ms               |
| 1     | 1     | 125ms                |

9) EIE bit (EVIN Interrupt Enable)

/INT Interrupt Enable/Disable selection bit. 0-disable;1-enable.

10) EVMON bit (EVIN Monitor)

EVMON can read the EVIN input level. 0-LOW; 1-HIGH.

### 6.2.9 ID Register

| Address | Function | bit7           | bit6 | bit5 | bit4 | bit3         | bit2 | bit1 | bit0 | Default |
|---------|----------|----------------|------|------|------|--------------|------|------|------|---------|
| 0x20    | ID       | Vendor ID[3:0] |      |      |      | Version[3:0] |      |      |      | 0xD4    |

Vendor ID: Vendor Code, Vendor ID[3:0]=1101b=Dh, Dh instead of DAPU.

Version: Chip Version.



# 7 I<sup>2</sup>C Bus Interface



I<sup>2</sup>C bus supports bi-directional communications through a serial clock line SCL and a serial data line SDA. I<sup>2</sup>C bus device can be defined as “Master” and “Slave”. INS5A8804 can only be used as Slave.

## 7.1 Cautions

I<sup>2</sup>C bus includes START, RESTART, STOP conditions, the duration between START and STOP must be less than 1 second just in case the bus to be set to standby mode automatically. A new START condition must be transferred before restarting of any communications.

INS5A8804 I<sup>2</sup>C bus interface supports single byte read/write operations as well as multiple bytes incremental access. After 0xFF address, the next one will be 0x00.

## 7.2 Slave Address

**Table12. I<sup>2</sup>C Bus Slave Address**

| Transfer data | Slave address |      |      |      |      |      |      | R/W       |
|---------------|---------------|------|------|------|------|------|------|-----------|
|               | bit7          | bit6 | bit5 | bit4 | bit3 | bit2 | bit1 | bit0      |
| 65h(Read)     | 0             | 1    | 1    | 0    | 0    | 1    | 0    | 1 (Read)  |
| 64h(Write)    |               |      |      |      |      |      |      | 0 (Write) |

INS5A8804 I<sup>2</sup>C bus Slave Address is [0110 010\*].



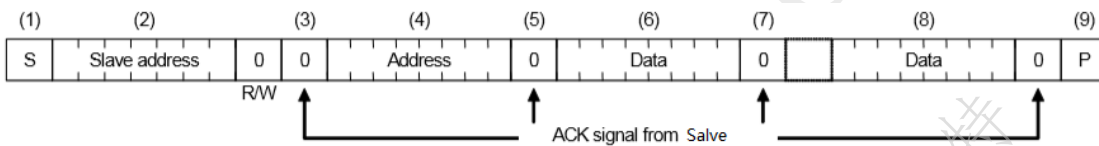
### 7.3 I<sup>2</sup>C bus protocol

It is assumed CPU is master and INS5A8804 is slave in this section.

#### 7.3.1 Write process

I<sup>2</sup>C bus includes an address auto-increment function, once the initial address has been specified, the INS5A8804 increments (+1) the address automatically after each data is sent, then to write next data.

- (1) CPU sends start condition[S]
- (2) CPU sends INS5A8804's slave address with R/W bit to set to write mode
- (3) CPU verifies ACK signal from INS5A8804
- (4) CPU sends write address to INS5A8804
- (5) CPU verifies ACK signal from INS5A8804
- (6) CPU sends write data to the address specified at step (4)
- (7) CPU verifies ACK signal from INS5A8804
- (8) Repeat (6) (7) if multiple bytes need to be written, address will be incremented automatically
- (9) CPU ends stop condition[P]



#### 7.3.2 Read process

Writing the address to be read with write mode firstly, then reading the data with read mode.

- (1) CPU sends start condition[S]
- (2) CPU sends INS5A8804's slave address with R/W bit to set to write mode
- (3) CPU verifies ACK signal from INS5A8804
- (4) CPU sends address for reading from INS5A8804
- (5) CPU verifies ACK signal from INS5A8804
- (6) CPU sends RESTART condition [Sr]
- (7) CPU sends INS5A8804's slave address with R/W bit to set to read mode
- (8) CPU verifies ACK signal from INS5A8804
- (9) CPU reads data from the specified address in step (4)
- (10) CPU sends ACK signal for "0"
- (11) Repeat (9) (10) if multiple bytes need to be read, address will be incremented automatically
- (12) CPU sends ACK signal for "1"
- (13) CPU sends stop condition[P]





## 8 Reflow Soldering Curve

Standard: IPC/JEDEC J-STD-020



Figure 3. Reflow Soldering Curve

Note: It is suggested to solder IC under the condition shown in the curve above. Must pay attention to the temperature and time when manual soldering, if the temperature over +260°C, or you will make the xo performance bad, even damage it.

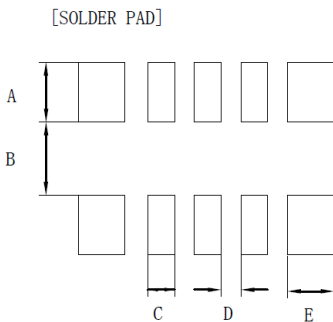
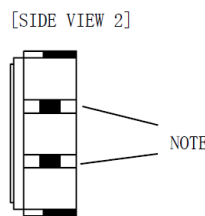


# 9 Dimensions



| Dimension | Min. | Typ. | Max. |
|-----------|------|------|------|
| <b>A</b>  | 3.1  | 3.2  | 3.3  |
| <b>B</b>  | 2.4  | 2.5  | 2.6  |
| <b>C</b>  | 0.8  | 0.9  | 1.0  |
| <b>D</b>  | --   | 0.45 | --   |
| <b>E</b>  | --   | 1.4  | --   |
| <b>F1</b> | --   | 0.4  | --   |
| <b>F2</b> | --   | 0.3  | --   |
| <b>G</b>  | --   | 0.6  | --   |
| <b>H</b>  | --   | 1.3  | --   |

unit: mm



| Dimension | Recommend |
|-----------|-----------|
| <b>A</b>  | 0.9       |
| <b>B</b>  | 1.1       |
| <b>C</b>  | 0.4       |
| <b>D</b>  | 0.3       |
| <b>E</b>  | 0.7       |

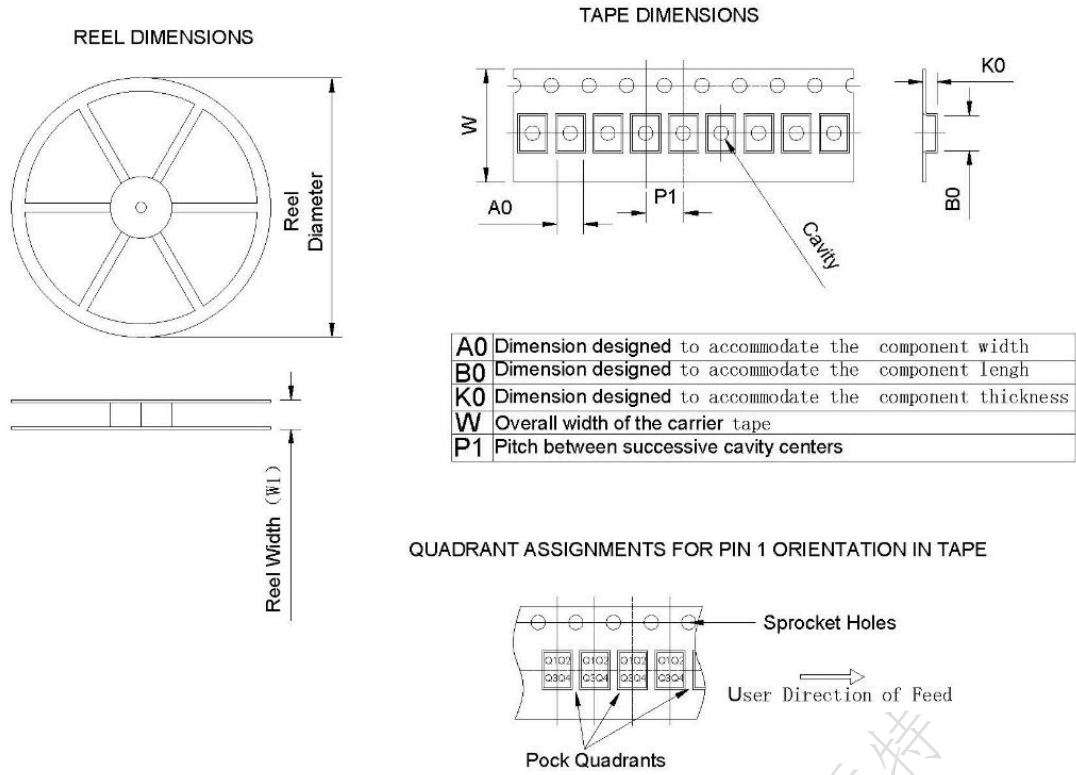
unit: mm

Note: The metal surface on the side shown in the figure is used for crystal test. Please avoid short circuit caused by contact between the metal surface and other electrical networks or other device surfaces during design and assembly.

Figure 4. Recommended Solder Pad and Dimensions



# 10 Package



| Device    | Package Type | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1(mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | PIN1 Quadrant |
|-----------|--------------|------|------|--------------------|-------------------|---------|---------|---------|---------|--------|---------------|
| INS5A8804 | Ceramic      | 10   | 3000 | 180                | 11.6±2.0          | 3.00    | 3.70    | 1.50    | 4       | 8.00   | Q1            |

Figure 5. Package



# 11 Revision History

| Version | Change Contents  | Prepared by | RevisedDate |
|---------|--|-------------|-------------|
| V1.0    | First issued   |             | 2022.11.28  |
| V2.0    | <ol style="list-style-type: none"> <li>1. Key Features:                             <ol style="list-style-type: none"> <li>1&gt; Change Low current consumption from 1.5uA to 1.8uA.</li> <li>2&gt; Add “RoHS2.0 &amp; REACH compliant”.</li> </ol> </li> <li>2. Chapter 4, Table1. Pin Definition:                             <ol style="list-style-type: none"> <li>1&gt; FOE Description, add “build in pull down resistor(Typ:500K Ω)”.</li> <li>2&gt; SOUT Description, correct to “SOUT is the inside state output(CMOS output)”.</li> <li>3&gt; Delete T2 description, change to NC.</li> </ol> </li> <li>3. Chapter5.2 Table3                             <ol style="list-style-type: none"> <li>1&gt; Change Current consumption typ value from 1.5uA to 1.8uA, add “VDD=3V” to Notes.</li> </ol> </li> <li>4. Chapter5.3 Table4                             <ol style="list-style-type: none"> <li>1&gt; Add “VDD=3V” to oscillation start time notes.</li> <li>2&gt; Year aging: add min value -5ppm.</li> </ol> </li> <li>5. Chapter5.4 Table5                             <ol style="list-style-type: none"> <li>1&gt; Correct IDD1/2/3/4                                     <ul style="list-style-type: none"> <li>IDD1 typ value from 1.6 to 1.9uA.</li> <li>IDD1 max value from 50 to 26uA.</li> <li>IDD2 typ value from 1.5 to 1.8uA.</li> <li>IDD2 max value from 45 to 25uA.</li> <li>IDD3 typ value from 4.5 to 4.8uA.</li> <li>IDD3 max value from 50 to 30uA.</li> <li>IDD4 typ value from 2.5 to 2.8uA.</li> <li>IDD4 max value from 45 to 28uA.</li> </ul> </li> </ol> </li> </ol> |             | 2023.07.24  |





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|  | <p>2&gt; Add IDD5/6/7/8/9/10 description and value.</p> <p>3&gt; Add VLF description and value.</p> <p>4&gt; Modify High-level input voltage max value 5.5V to Vdd.</p> <p>6. Chapter5.5 Table6:</p> <p>1&gt; Correct SCL/SDA tr/tf max value from 0.4us to 0.3us.</p> <p>7. Chapter6 Registers</p> <p>1&gt; Delete 0x0E Bit0 “VDET” and description.</p> <p>2&gt; Delete 0x15 Bit6 “TSVDET” and description.</p> <p>3&gt; Table9 change to “ID Registers”, delete RSV register and add 0x20 register description.</p> <p>4&gt; Note description Initial0: delete “TSVDET”, “All bits of address 1Ch, 1Dh, 1Eh”.</p> <p>5&gt; Note description Initial1: delete “VDET”, add “All bits of address 1Ch, 1Dh, 1Eh”.</p> <p>6&gt; Note description: delete “VDET” in “Only 0 can be written to UF, TF, AF, VLF, VDET bits”.</p> <p>7&gt; Add description “Forbidden to modify the register except 6.1 register list and RSV register”.</p> <p>8&gt; Correct an error in 6.2.3, modify the description from “REES” to “TRES”.</p> <p>9&gt; Chapter 6.2.5, delete bit0 “VDET” and description, modify VLF value from “1.6V” to “1.3V(Typ)”.</p> <p>10&gt; Chapter 6.2.6, modify RESET bit description from “RESET IC” to “RESET divider”, and add more detail information for this bit.</p> <p>11&gt; Chapter 6.2.7, delete FS[2:0] config 100 SOUT Output VDET signal in the table. Modify FS[2:0] config 011 SOUT output from “LOW” to “EF”.</p> <p>12&gt; Chapter 6.2.8, delete 0x15 bit6 “TSVDET” and item2 description “VDET bit to</p> |  |  |
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|      | <p>TSVDET”.</p> <p>13&gt; ADD Chapter 6.2.9 ID Register description.</p> <p>8. Chapter 7.1</p> <p>1&gt; Modify “0x7F address” to “0xFF address”</p> |  |            |
| V2.1 | <p>1. Chapter 6.2.7: Correct an error, modify “0x69 = 0x69” to “0x19 = 0x69”</p>  |  | 2023.08.01 |
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