

# SCA3000 FAQ List

## 1 Introduction

This technical note gives answers to frequently asked SCA3000 related questions. All information related to the SCA3000 usage, operation, register description etc. can be found from the latest version of the document: "**SCA3000 Product Family Specification**" (doc no 8257300). Always when designing a new system for SCA3000, please use the latest documentation versions:

- SCA3000 PFS (SCA3000 Product Family Specification)
- SCA3000 product type specific data sheets

All SCA3000 related documentation is available from SCA3000 product pages:

<http://www.vti.fi/en/products-solutions/products/accelerometers/sca3000-accelerometers/>

Or from SCA3000 demo kit pages:


<http://www.vti.fi/en/products-solutions/products/accelerometers/sca3000-accelerometers/sca3000-demo-kit/>

## 2 SCA3000 FAQ list

Table 1. SCA3000 FAQ (Frequently Asked Questions) list.

ITEM	i/f	Problem	Actions	Refer to SCA3000 documentation
1	SPI/ I <sup>2</sup> C	Communication / general operation problems	Check the SCA3000 circuit diagram → SCA3000 requires 3 supply filtering capacitors, one for each supply pin: AVDD, DVDD, DVIO → CLK pin needs to be grounded	The latest SCA3000 PFS section 7.2
2	SPI/ I <sup>2</sup> C	Communication / general operation problems	Check the SCA3000 PCB layout → Supply filtering capacitors should be located as close the SCA3000 supply pins as possible	The latest SCA3000 PFS section 7.3
3	SPI/ I <sup>2</sup> C	Communication / general operation problems	Is SCA3000 soldered properly? SCA3000 is not optimized for manual soldering. See also SCA3000 test PWB (item 35)	TN54 SCA3000 Accelerometer Assembly Instructions
4	SPI/ I <sup>2</sup> C	Performance: Noise / unstable acceleration readings	SCA3000 acceleration output data is in 2's complement format. If 2's complement conversion is not applied in application sw, the output data may seem to be very noisy	The latest SCA3000 PFS section 3.3
5	SPI/ I <sup>2</sup> C	Performance: Noise / unstable acceleration readings	SCA3000 has a product specific turn on time. The acceleration output will be within 1% of its final value after the turn on time.	Sensor data sheet and the latest SCA3000 PFS section 8.7
6	SPI/ I <sup>2</sup> C	Performance: Noise / unstable acceleration readings	A very slow or noisy supply voltage rising up ramp and glitches in supply voltage during SCA3000 start up may cause problems in sensor internal memory reading. In case such a problem occurs, the sensor output signal may behave irrationally. These cases can be detected by reading the EEPROM check sum error after the SCA3000 start up. In case of checksum error the SCA3000 should be restarted by pulling the XRESET pin low and then back to high state.	The latest SCA3000 PFS section 2.1
7	SPI/ I <sup>2</sup> C	Performance: Noisy / unstable / jumpy acceleration readings	SCA3000 acceleration output values are not limited. This means that if SCA3000 experiences accelerations that are much bigger than the sensor's specified measuring range, eventually the acceleration output registers will overflow. This can be avoided by using a sensor type with a proper measurement range for environment or by limiting the accelerations the sensor is experiencing (e.g. adding mechanical damping to sensor's attachment to the environment)	The latest SCA3000 PFS section 2.2.2.1

ITEM	i/f	Problem	Actions	Refer to SCA3000 documentation
8	SPI/ I <sup>2</sup> C	Overall communication problems	Check that DVIO pin is connected in correct way. The voltage level connected to DVIO pin is used as a reference for internal level shifter circuitry.	The latest SCA3000 PFS section 7.2
9	SPI	SPI communication problems	Check that CSB is pulled up to '1' after each communication frame. CSB is '1' also, when there is no communication with the SCA3000	The latest SCA3000 PFS section 4.1.1, figure 6.
10	SPI	SPI communication problems	Check that: <ul style="list-style-type: none"> <li>• MCU reads / samples the bits from MISO line on correct edge of the SCK pulse</li> <li>• MCU writes the bits to MOSI line on correct edge of the SCK pulse</li> </ul>	The latest SCA3000 PFS section 4.1.1
11	SPI	SPI communication frame error	SPI bus frame error (FRME) bit indicates that in previous SPI communication frame: <ul style="list-style-type: none"> <li>• the number of received SCK pulses was not divisible by 8 or</li> <li>• the total number of SCK pulses was below 16</li> </ul> That SPI frame is ignored and considered invalid	The latest SCA3000 PFS section 4.1.2
12	SPI	SPI communication problems	Make sure that before and after the SPI frame the serial clock (SCK) starts and ends at low state	The latest SCA3000 PFS section 4.1.1, figure 6.
13	SPI	Unable to unlock the SCA3000	Unlock sequence needs to be written as separate SPI commands e.g. three separate SPI communication frames has to be sent, CSB is pulled high between each SPI frame (after each byte that is written)	The latest SCA3000 PFS section 4.1.1, figure 6 and section 3.4.
14	SPI	What means decremented SPI read?	When reading SCA3000 output data registers, the SCA3000 decreases automatically the register address by one, if the host continues sending the SCK pulses after 1 <sup>st</sup> register read.	The latest SCA3000 PFS section 4.1.3.2.
15	I <sup>2</sup> C	How SCA3000 I <sup>2</sup> C address can be changed?	The default SCA3000 I <sup>2</sup> C device address can not be changed. The default address is 0x1F1.	The latest SCA3000 PFS section 4.2
16	SPI/ I <sup>2</sup> C	After OUT_CTRL register configuration, the SCA3000 output registers are not updated	If the host system has configured SCA3000 OUT_CTRL register contents, make sure that the OUT_CTRL reserved bits [7:5] are written in as 111, otherwise the SCA3000 will not update its normal acceleration output registers	The latest SCA3000 PFS section 3.4, OUT_CTRL register bit level description.
17	SPI/ I <sup>2</sup> C	Changing operation mode	SCA3000 asic utilizes different HW implementation in motion detection mode and in measurement mode. When changing from the motion detection mode to measurement mode, the host system should let SCA3000 output values to stabilize for the period of product specific turn on time.	Sensor data sheet and the latest SCA3000 PFS section 8.7
18	SPI/ I <sup>2</sup> C	Motion detection mode	The only information the SCA3000 offers in Motion Detection mode is the interrupt via INT-pin after motion is detected (and the information of what axis exceeded threshold level).	The latest SCA3000 PFS section 2.3
19	SPI/ I <sup>2</sup> C	Motion detection mode	Even though motion is detected, the detected acceleration peak value is not stored in any register. The INT_STATUS register shows what axis exceeded threshold level.	The latest SCA3000 PFS section 2.3 and section 3.3.
20	SPI/ I <sup>2</sup> C	Free Fall detection	Normal acceleration output (also from ring buffer) is available when Free Fall detection is enabled. Free Fall detection parameters are pre-configured and can not be changed by user: e.g. user can only enable/disable the Free Fall detection.	The latest SCA3000 PFS section 2.4
21	SPI/ I <sup>2</sup> C	What is SCA3000 output sample rate [samples/sec]?	The SCA3000 output sample rate depends on the sensor type and used measurement mode. For example SCA3000-D01 sample output sample rate is 250 samples/sec in normal measurement mode, which means that all three XYZ samples are updated 250 times per second.	Sample output data rate is specified in sensor data sheet
22	SPI/ I <sup>2</sup> C	When does SCA3000 update the acceleration output data registers?	SCA3000 updates all the output data registers when any of the acceleration MSB registers is accessed: e.g. when decremented read is started from any of the MSB register, all the other acceleration registers are updated also, see details of decremented read option in item 14.	
23	SPI/ I <sup>2</sup> C	MCU reads SCA3000 registers faster than the sensor output sample rate	If the host system reads SCA3000 output data registers faster than the specified sensor output sample rate, the host system gets the same acceleration data multiple times, until the sensor updates the output data registers	
24	SPI/ I <sup>2</sup> C	How to determine accurate SCA3000 sample rate?	If sensor specific accurate sample rate is required, the host system can calculate it based on the time between two consecutive interrupts when ring buffer is used, see more details section 2.1 below.	Ring buffer details in the SCA3000 PFS section 2.5

ITEM	i/f	Problem	Actions	Refer to SCA3000 documentation
25	SPI/ I <sup>2</sup> C	Ring buffer functionality	After SCA3000 start up, the ring buffer is disabled. Ring buffer starts to store data right after it is enabled. The ring buffer configurations should to be completed before the ring buffer is enabled. The same acceleration data can be read out from ring buffer and normal acceleration output registers.	The latest SCA3000 PFS section 2.5
26	SPI/ I <sup>2</sup> C	Ring buffer sample rate	After enabling the ring buffer stores all the measured acceleration values by default (e.g. ring buffer sample rate is same as sensors output data rate). The ring buffer sample rate can be reduced so that only every 2nd or every 4th acceleration sample is stored in to ring buffer, see section 2.2 below (Table 2 and Equation 1)	The latest SCA3000 PFS section 2.5, see also section 2.2 below (Table 2 and Equation 1).
27	SPI/ I <sup>2</sup> C	Does ring buffer store data during the data read out period?	Ring buffer is a FIFO type (First In First Out) where the oldest data is shifted out first. It has separate read and write address pointers, so it can be read and written simultaneously.	The latest SCA3000 PFS section 2.5
28	SPI/ I <sup>2</sup> C	What happens if ring buffer data is not read out?	If the ring buffer data is not read out before the buffer is full (BUF_COUNT reaches the value of 192), the ring buffer data content is lost. After losing the data, the ring buffer continues to sample new data in to empty buffer, see more details section 2.1 below.	The latest SCA3000 PFS section 2.5 and section 2.1 below.
29	SPI/ I <sup>2</sup> C	Axis are swapped in the ring buffer data	The BUF_COUNT register contains information of how many values are stored in to ring buffer. If the number of samples read out from ring buffer is not divisible by the number of stored axis, the next data reading results in different axis order: If three axis XYZ data is stored in to ring buffer and the number of samples read out from the buffer is 92, the resulting set of data will contain 30 samples of XYZ data (3*30=90 samples), and additional two acceleration values, one value from X axis and the other value from Y axis. The 1 <sup>st</sup> value in the next ring buffer reading will contain the Z-axis value from the previous round.	The latest SCA3000 PFS section 2.5
30	SPI/ I <sup>2</sup> C	Temperature	Temperature information is available only from SCA3000-D01 and SCA3000-D02. The TEMP_MSB register must be read before the TEMP_LSB register in order to get valid temperature data. Registers are updated with the latest temperature data when accessed. The result is converted to [°C] by using a specific equation.	The latest SCA3000 PFS section 2.6
31	SPI/ I <sup>2</sup> C	Has SCA3000 an analog output?	SCA3000 has no analog outputs.	The latest SCA3000 PFS section 5 and 7
32	SPI/ I <sup>2</sup> C	How SCA3000 data sheet values are defined, how they can be measured?	SCA3000 data sheet references are presented in SCA3000 PFS.	The latest SCA3000 PFS section 8
33	SPI	Is there a reference C-code for SCA3000?	There is a C-code reference for SCA3000-D01 available.	TN55 C-code example for SCA3000
34	SPI/ I <sup>2</sup> C	Is there an evaluation kit for SCA3000?	The SCA3000 demo kit can be used as an evaluation/development kit. It supports all SCA3000 product types and the user has full SCA3000 register access as well as data logging capabilities.	See <a href="#">SCA3000 demo kit</a> link from SCA3000 product pages
35	SPI/ I <sup>2</sup> C	How SCA3000 can be easily contacted?	Please use SCA3000 test PWB with soldered component. The SCA3000 test PWBs are compatible with SCA3000 demo kit.	SCA3000 PWB specification 8258600A (see demo kit web pages)
				
36	SPI/ I <sup>2</sup> C	How to log SCA3000 output data in to file?	SCA3000 demo kit can be used for data logging purposes.	See SCA3000 DEMO KIT User Manual 8259300 section 5
37	SPI/ I <sup>2</sup> C	Abnormal sensor behaviour	Has SCA3000 experienced any kind of ultrasonic agitation during assembly & testing process (ultrasonic cleaning, welding, etc)? → ultrasonic agitation may damage SCA3000 sensor and thus it is not allowed	The latest SCA3000 PFS section 5.1

## 2.1 Ring buffer usage

In order not to lose the ring buffer data content due to buffer filling up 100% (e.g. BUF\_COUNT register over flow), the data should be read out periodically. Please note that system can be designed also in a way that the BUF\_COUNT register is not used at all:

- enable the ring buffer interrupt (INT\_MASK.BUF\_H\_EN or INT\_MASK.BUF\_F\_EN)
- enable the ring buffer (MODE.BUF\_EN)
- wait for the INT-pin interrupt
- read the INT\_STATUS register to clear the interrupt
- after INT-pin interrupt the host system knows that the buffer has a certain amount of samples, for example 75% full means that ring buffer has 144 samples =  $0,75 \cdot 192$  samples
- read a constant pre-defined amount of samples out from the ring buffer, for example 144 samples
- wait for the next INT-pin rising edge

When the ring buffer is used as described above, the BUF\_COUNT register does not over flow and the ring buffer data is not lost. If an accurate SCA3000 sample rate is required, the sample rate can be calculated in host system by using the sequence described above.

The sample rate is the time between the two consecutive INT-pin interrupts divided by the number of samples the host has read out from the BUF\_DATA register (notice that one sample contains all the three XYZ axis acceleration values).

## 2.2 Ring buffer configurations

In Table 2 below is presented examples of different SCA3000-E05 ring buffer configurations and data storage times.

Table 2. SCA3000-E05 ring buffer configurations and realized data storage periods.

Measurement mode:	Ring buffer sample rate divider: BUF_RATE bits	Output signal -3dB cut off frequency [Hz]	Output data rate from normal output registers [samples/sec]	Ring buffer sample Rate [samples/sec]	Ring buffer holds XYZ data for period of [ms] <sup>(1)</sup>	Ring buffer holds X-axis data for period of [ms] <sup>(2)</sup>
Normal measurement mode	00 – no rate reduction	60	200	200	240 ms $=0,75 \cdot 192 / 3 \cdot 1 / 200$	720 ms $=0,75 \cdot 192 / 1 \cdot 1 / 200$
	01 – divide rate by 2	60	200	100 $= 200 / 2$	480 ms $=0,75 \cdot 192 / 3 \cdot 1 / 100$	1440 ms $=0,75 \cdot 192 / 1 \cdot 1 / 100$
	10 – divide rate by 4	60	200	50 $= 200 / 4$	960 ms $=0,75 \cdot 192 / 3 \cdot 1 / 50$	2880 ms $=0,75 \cdot 192 / 1 \cdot 1 / 50$
	11 – no rate reduction	60	200	200	240 ms $=0,75 \cdot 192 / 3 \cdot 1 / 200$	720 ms $=0,75 \cdot 192 / 1 \cdot 1 / 200$
Narrow band mode	00 – no rate reduction	9	50	50	960 ms	2880 ms
	01 – divide rate by 2	9	50	25	1920 ms	5760 ms
	10 – divide rate by 4	9	50	12,5	3840 ms	11520 ms
	11 – no rate reduction	9	50	50	960 ms	2880 ms
Wide band mode	00 – no rate reduction	75	400	400	120 ms	360 ms
	01 – divide rate by 2	75	400	200	240 ms	720 ms
	10 – divide rate by 4	75	400	100	480 ms	1440 ms
	11 – no rate reduction	75	400	400	120 ms	360 ms

<sup>1)</sup> Ring buffer configuration: store all 3-axis (XYZ) data, give interrupt after ring buffer is 75% full.

<sup>2)</sup> Ring buffer configuration: store single axis (X-axis) data, give interrupt after ring buffer is 75% full.

The SCA3000 ring buffer data storage times in general can be estimated with the following equation:

**Equation 1:**

$$Buffered\_time = BUF\_FULL \cdot \frac{192}{\#\_of\_axis} \cdot \frac{1}{output\_data\_rate}$$

where the

- *Buffered\_time* is the time how long the ring buffer can store the data before giving an interrupt
- *BUF\_FULL* is the level at which the ring buffer is when interrupt is given:
  - If the bit BUF\_H\_EN=1, the interrupt is given when the ring buffer is 50% full: set 0,5 to equation
  - If the bit BUF\_F\_EN=1, the interrupt is given when the ring buffer is 75% full: set 0,75 to equation
- *#\_of\_axis*, how many axis data is stored
- *output\_data\_rate*, the output data rate of the used SCA3000 component type in certain measurement mode

### 3 Document Revision History

Revision	Date	Change Description
0.1	17.03.2008	First release