BINARY PROTOCOL SPECIFICATION

SCA10H

Doc. No. 1327 Rev. 1

Table of Contents

1 Frame format

Table 1 Frame format

Attribute	Length(Bytes)	Description
SOF	1	Start of Frame, value 0xFE
LEN	1	Length of the payload (excluding SOF, LEN, TYPE, ID and FCS fields)
TYPE	1	Type of the frame
ID	2	Type specific ID
Payload	variable	Type specific payload
FCS	1	Frame Checksum Calculated as an exclusive or (XOR) of all of the preceding bytes of the frame

1.1 Frame types

Table 2 Frame types

Type	ID
0x00: Data	0x0000: BCG data 0x0001: Data logger data (1-axis, AC) 0x0002: Calibration progress 0x0003: Reset indication 0x0004: 2-channel data logger data (1-axis, AC+DC) 0x0005: Status
0x01: Command request	0x0200: Reset 0x0201: Get firmware version 0x0202: Clear timestamp 0x0203: Set mode 0x0204: Get mode 0x0205: Set parameters and reset 0x0206: Get parameters 0x0207: Set default parameters and reset 0x0208: Set measurement direction 0x0209: Get measurement direction 0x020A: Set self-test pin 0x020B: Reserved 0x020C: Get serial number 0x020D: Set factory defaults and reset 0x020E: Reserved 0x020F: Set payload type 0x0210: Get payload type

1.2 Request and response

A response frame is sent for every command request frame. Command ID for response frame is the request ID with most significant bit set. For example:

Reset request: 0x0200
Reset response: 0x8200

Many of the requests do not have payload so the payload length field of the frame is therefore zero.

For responses not including other data the payload is generally a status byte:

0x00	Success
not 0x00	Failure indication

1.3 Data endianness and size

Data is transferred in little-endian format: the least significant byte (LSB) is sent first, the most significant byte last.

Data types used by the module data transfer are unsigned 8-bit integer (U8), signed 16-bit (S16) and 32-bit integer (S32). Frame ID is sent as 16-bit integer similarly LSB first.

2 Data formats

The module (SCA10H) writes output data to the data interface asynchronously. Output data format and data transfer interval depends on the running mode of the module. The mode can be set with a command request.

2.1 BCG data

The module measures acceleration with 1 kHz interval and runs the result through a data processing algorithm. Processed output data is written @1Hz rate to the data interface.

Timestamp, measured signal strength and status are updated continuously, the rest of the parameters only when heartbeat is found. If heartbeat is not found in 5 seconds, all results except timestamp, signal strength and status will be cleared.

BCG data frame:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x28	0x00	0x0000	data	--

Payload data is defined as follows:

Table 3 BCG payload

Variable	Data type	Unit	Description
time_stamp	S32		System timestamp
HR	S32	1/min	Heart rate
RR	S32	1/min	Respiration rate
SV	S32	ml	Relative stroke volume
HRV	S32	ms	Heart rate variability
signal_strength	S32	arbitrary unit	measured signal strength indication
status	S32		0 = low signal 1 = ok signal 2 = high signal 3 = (close to) overload 4 = (close to) max HR
B2B	S32	ms	Beat-to-beat time
B2B1	S32	ms	Beat-to-beat time*

B2B2	S32	ms	Beat-to-beat time*

*These parameters are non-zero if two/three beats have been detected during one second

2.2 Data logger data (1-axis, AC)

The module measures and sends raw acceleration data with 1 kHz interval.

Data logger data frame:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x02	0x00	0x0001	data	--

Payload data is defined as follows:

Table 4 Data logger payload

Data type	Description
S16	Raw acceleration data

2.3 Calibration progress

The module indicates the progress of calibration.

The message is sent continuously at 1 Hz rate.

Calibration progress data frame:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x03	0x00	0x0002	data	--

Payload data is defined as follows:

Table 5 Calibration progress payload

Data type	Description
U8	Calibration phase (2 = Empty bed or 3 = Occupied bed)
U8	Calibration step 0x00: Start of calibration 0x01 - 0xFE: Time since the start of the calibration (seconds) 0xFF: End of Calibration
U8	Calibration flags (bit field) 0x01: Tentative stroke volume missing - calibration phase 2 is run without running phase 1 first. The module returns to BCG mode 0x02: Signal is noisy for calibration – risk of inaccurate calibration 0x04: Signal is weak for calibration - risk of inaccurate calibration Calibration is completed successfully without warnings when calibration flags are 0x00

2.4　　　Reset indication

The module is reset and starts the operation in the reported mode.

Reset indication data frame:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x00	0x0003	data	--

Payload data is defined as follows:

Table 6 Reset indication payload

Data type	Description
U8	Running Mode

Table 7 Running modes

Mode	Description
0: BCG (Default)	The module measures acceleration with 1kHz interval and runs the result through the BCG algorithm. Processed output data is sent @1Hz rate.
1: Data logger (1-axis, AC)	The module measures and sends raw acceleration data with 1kHz.
2: Calibration phase 1	Empty bed calibration. The module measures empty bed for 60 seconds and saves the intermediate parameters to flash memory.
3: Calibration phase 2	Occupied bed calibration. The module measures occupied bed for 60 seconds, saves the calibration parameters and resets to BCG mode after completion.
4: 2-channel data logger (1-axis, AC+DC)	The module measures and sends raw AC and DC data with 1kHz.
5: Reserved	
6: Reserved	
7: Reserved	
8: Reserved	
9: Sleep mode	The module turns voltage regulator off and goes to sleep mode. The module can be woken up by a low-to-high trigger signal on MCU_INTERRUPT_IN. After waking up the module will listen for commands (for example, to change the operating mode). The module will wake up also from UART receive, but the module may receive the first frame as corrupted.

2.5　　　2-channel data logger (1-axis, AC+DC) data

The module measures and sends raw AC and DC data with 1 kHz interval.

2-channel data logger data frame:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x04	0x00	0x0004	data	--

Payload data is defined as follows:

Table 8 2-channel data logger payload

Data type	Description
S16	Raw AC data
S16	Raw DC data

2.6   Status

Status data informs the host about various conditions.

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x00	0x0005	data (U8)	--

Payload data is defined as follows:

Table 9 Status payload

Value	Description	Notes
0x00	Frame receive timeout	The error occurs if the frame transfer is not completed within 1000 ms after SOF.
0x01	Frame checksum error	
0x02	Illegal frame length	The received frame length does not match the length in the command specification.
0x03	Start of Frame not found	The first byte after the previous completed frame is not SOF. The module continues operation and waits for SOF in the next byte. The error status message is sent only once per erraneous frame.
0xFF	Test mode ACK	The module has received an input value and is ready to receive the next frame.

3   Commands

Commands are sent from the host to the module. The module responds to all commands with a response message.

3.1   Reset

Reset the module.

Request from a host:

SOF	LEN	TYPE	ID	FCS
0xFE	0x00	0x01	0x0200	0xFD

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x8200	0 = success 0xFF = fail	--

3.2 Get firmware version

Get firmware version from the module. Version is defined as a variable length ASCII string formatted as "FW name_X.X.X.X". The string is not null terminated i.e. the payload length is exactly the amount of visible characters.

Example:
"BCG Sensor_3.0.0.0"

Request from a host:

SOF	LEN	TYPE	ID	FCS
0xFE	0x00	0x01	0x0201	0xFC

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	variable	0x01	0x8201	ASCII string	--

3.3 Clear timestamp

Request from a host:

SOF	LEN	TYPE	ID	FCS
0xFE	0x00	0x01	0x0202	0xFF

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x8202	0 = success 0xFF = fail	--

3.4 Set mode and reset

Set the running mode of the module and reset. The mode is written to flash memory.

Refer to table Running modes (page 6) for the payload definition.

Request from a host:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x0203	mode (U8)	--

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x8203	0 = success 0xFF = fail	--

3.5 Get mode

Refer to table Running modes (page 6) for the payload definition.

Request from a host:

SOF	LEN	TYPE	ID	FCS
0xFE	0x00	0x01	0x0204	0xF9

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x8204	mode (U8)	--

3.6 Set parameters and reset

Set BCG parameters to the module and reset. The parameters are written to flash memory.

The payload is defined as follows:

Table 10 Parameters

Variable	Data type	Default value
var_level_1	S32	7000
var_level_2	S32	270
stroke_vol	S32	5000
tentative_stroke_vol	S32	0
signal_range	S32	1500
to_micro_g	U8	7

Request from a host:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x15	0x01	0x0205	data	--

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x8205	0 = success 0xFF = fail	--

3.7 Get parameters

Refer to table Parameters (page 9) for payload data.

Request from a host:

SOF	LEN	TYPE	ID	FCS
0xFE	0x00	0x01	0x0206	0xFB

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x15	0x01	0x8206	data	--

3.8 Set default parameters and reset

User defined BCG parameters are erased from the flash memory and the module is reset.

Request from a host:

SOF	LEN	TYPE	ID	FCS
0xFE	0x00	0x01	0x0207	0xFA

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x8207	0 = success 0xFF = fail	--

3.9 Set measurement direction

Set the direction of the BCG measurement to normal or inverted module installation. The value is stored in flash memory.

0 = Normal direction. Sensor's arrow points to the direction of the head. (Default)
1 = Inverted direction. Sensor's arrow points to the direction of the feet.

Request from a host:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x0208	direction (U8)	--

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x8208	0 = success 0xFF = fail	--

3.10 Get measurement direction

Get the current value of the measurement direction. Refer to section 3.9 for payload data.

Request from a host:

SOF	LEN	TYPE	ID	FCS
0xFE	0x00	0x01	0x0209	0xF4

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x8209	direction (U8)	--

3.11 Set self-test pin

Set the state of the accelerometer self-test pin. Note: Set self-test disabled for normal operation.

0 = Self-test disabled
1 = Self-test enabled

Request from a host:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x020A	state (U8)	--

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x820A	0 = success 0xFF = fail	--

3.12 Get serial number

Get thirteen digit alphanumeric serial number (XXX XX XXXXX -XX) as an ascii string. The string is not null terminated i.e. the payload length is exactly the amount of visible characters.

Request from a host:

SOF	LEN	TYPE	ID	FCS
0xFE	0x00	0x01	0x020C	0xF1

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x0D	0x01	0x820C	Ascii string	--

3.13 Set factory defaults and reset

Erase parameters and settings from flash memory. BCG parameters, BCG direction, payload type and running mode will be cleared to default values.

Serial number is not erased.

Request from a host:

SOF	LEN	TYPE	ID	FCS
0xFE	0x00	0x01	0x020D	0xF0

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x820D	0 = success 0xFF = fail	--

3.14 Set payload type

Set the BCG data payload type. The value is written to flash memory.

0 = timestamp,HR,RR,SV,HRV,signal_strength,status,B2B,B2B1,B2B2 (Default)
1 = timestamp,HR,RR,SV,signal_strength,status,tbeat1,tbeat2,tbeat3,tbeat4

Request from a host:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x020F	type (U8)	--

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x820F	0 = success 0xFF = fail	--

3.15   Get payload type

Get the BCG data payload type. Refer to section 3.14 for payload data.

Request from a host:

SOF	LEN	TYPE	ID	FCS
0xFE	0x00	0x01	0x0210	0xED

Response from the module:

SOF	LEN	TYPE	ID	Payload	FCS
0xFE	0x01	0x01	0x8210	type (U8)	--

4   Document Change Control

Rev.	Date	Change Description
1	25-Sep-15	Document moved to new control system and template. Test related commands removed from the document.