

SGS – Smart Geophone Sensor

User Manual

SGSK-00001, SGSK-00002, SGSK-00003, SGSK-00004, SGSK-00007
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1 Introduction

Congratulations for purchasing the SGS Smart Geophone Sensor. The SAS smart geophone sensor is a Precise, Rugged and Versatile Embedded Vibration Meter.

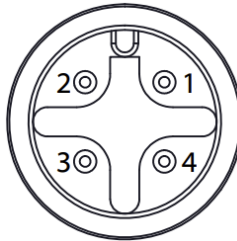
- 2.7kHz Sampling Rate;
- 0.5 Hz – 400 Hz 1/3 Octave Bands
- Complies to ISEE and DIN 45669-1.
- Automatic Sensor Check;
- Rugged and Compact Form-Factor;
- Digital communication avoiding electrical interferences;
- Up-To 100m cable length.

2 Installation

2.1 Connection

The SGS uses RS485 half-duplex serial communication. A shielded 4-pin M12 male connector is used with supply and differential half-duplex signaling:

Pin	Description
1	RS-485 Pos.
2	RS-485 Neg.
3	+5V
4	Ground
Shell	Ground



The electrical supply must be able to provides 0.7A at 5V (the SGS average consumption is maximum 400 mA).

Only one SGS sensor is possible on a single serial port: the daisy-chain architecture, where many sensors are on the same port, is not supported for the SGS and the maximum length for the cable length between the host and the sensor is 100 meters.

3 Programming

3.1 Serial Port Configuration

The SGS uses RS485 half-duplex serial communication with the following specifications:

- BaudRate: 3 MBPS
- WordLength: 8 bits
- StopBit: one bit
- Parity: No
- Control flow: No

3.2 Protocol Description

The SGS communication protocol is based on a set of commands and responses:

- 1) The host sends a command of 12 bytes to the SGS;
- 2) The SGS replies with the requested data and/or with an acknowledge.

The host must wait at least 5ms after receiving data from the SGS for the SGS to be ready to receive another command.

Whenever 16-bit integers, 32-bit integers or 32-bit floating point numbers are present in the command or payload, it must be represented with LSB-First topology (Least significant byte first).

3.3 Checksum

The protocol uses a simple checksum to validate the host commands and SGS data. Below is a code example to compute the checksum for a buffer of bytes:

```
unsigned char CheckSum = 0; // 8-bit unsigned
for (int i = 0; i < BytesBufferSize; i++)
{
    CheckSum = CheckSum ^ BytesBuffer[i];    // ^ operator is XOR
}
```

3.4 Initialization and Configuration

- 1) Configure the Host serial port (Serial Port Configuration);
- 2) Open the serial port socket;

- 3) The Host sends the Get Board Info command to validate that the connected sensor is an SGS.
- 4) The Host sends the Get Sensor Info command to determine the serial number of the SGS and validate the firmware version.
- 5) Set Sensor Configuration for your application. If the SGS is not configured, it will use the last configuration from its non-volatile memory.

3.5 Hardware and Firmware Compatibility

The Get Sensor Info command returns the SGS serial number and firmware version.

The SGS Model can be determined from the SGS serial number. Below is an example for serial number "GS0423102207":

- "GS": SGS
- "04": model ID "4"
- "231022": Manufacture batch ID
- "07": Specific ID in batch.

The table below indicates the hardware and firmware compatibility:

Model ID	1	2	3	4	5	6	8	9
Model Name	ISEE	DIN	HS1	HS1	ISEE Bore-Hole	DIN Bore-Hole	V2	V2 Bore-Hole
Fu (Hz)	2	1	5	10	2	1	[1-8] (1/1 Octave)	
Fo (Hz)	250	80	100	200	250	80	[80-400] (1/3 Octave)	
Fu Index	0						[0-3]	
Fo Index	0						[0-7]	
KBFmax available	NO	YES	NO	NO	NO	YES	YES for 1Hz-80Hz	
Tilt Sensor	NO						YES	NO
Buffer Length	10s						30s	
Compatible Firmware	4						1	

3.6 Typical Applications

The SGS may be used for real-time data acquisition or for average data acquisition. These two typical applications are detailed below.

It's also possible to combine these two modes of operation by performing real-time acquisition and average data acquisition in the same process.

3.6.1 Real-Time Data

For this application, the Host reads every data block and/or waveform block in real-time.

While the most common application is to read every data and waveform block, it's also possible to read every data block, but read only specific waveform blocks when a threshold is exceeded for example. Thanks to the SGS buffer, the host may read blocks in the buffer up to 30s in the past. Refer to section 3.5, Hardware and Firmware Compatibility, for more information.

Reset Buffer

- 1) Reset Buffer Status to initialize the buffer (This step resets the block counter to zero);
- 2) Set a "Block ID" variable to zero.

Query Buffer Status

- 3) Periodically Get Buffer Status and compare the returned "Buffer Last Block ID" to the "Block ID" variable.

If the "Buffer Last Block ID" is greater than the "Block ID" variable, it means that blocks are ready to be read from the buffer.

The host may read any Block ID in the buffer. The available Block IDs are determined from the "Buffer Last Block ID" and the "Buffer Number of Blocks". Below is an example:

- Buffer Last Block ID = 842576
- Buffer Number of Blocks = 100
- Any Block ID from 842477 to 842576 can be read.

Read Blocks

- 4) Increment the "Block ID" variable;
- 5) Read the Block ID Data and/or Waveform using the following set of functions:
 - Get Data;
 - Get Waveform;
 - Get Combined Data and Waveform.

The host may read several blocks one after the other for as long as the "Buffer Last Block ID" is greater than the "Buffer Last Block ID".

3.6.2 Average Data

For this application, the Host reads average data on fixed intervals.

Reset Average

- 1) The Host resets the SGS running average by sending the Get/Reset Average Data command;

Wait for Interval

- 2) The Host waits for the average to complete using its own time reference.

Read Data and Reset Average

- 3) The Host reads the SGS running average by sending the Get/Reset Average Data command;

The Get/Reset Average Data command also resets the average. The Host may proceed directly to "Wait for Interval" for the next average.

3.7 Commands Description

3.7.1 Get Board Info

This command is the first command used to determine the presence of the sensor. The Vendor ID value must be 0x1612 and the Product ID must be 0x0108. The protocol sequence is:

The host sends the following 12-bytes command:

[0]	0x42
[1]	0x6F
[2]	0x61
[3]	0x72
[4]	0x64
[5]	0x49
[6]	0x6E
[7]	0x66
[8]	0x6F
[9]	0x2D
[10]	0x2D
[11]	Checksum

The SGS replies with 8 bytes:

[0-1]	Vendor ID (Unsigned 16-bit) (0x1612)
[2-3]	Product ID (Unsigned 16-bit) (0x0108)
[4-5]	Reserved
[6]	Checksum

[7] Acknowledge (0x32)

3.7.2 Get Sensor Info

This command is used to read the serial number and firmware. This information is important to determine the Hardware and Firmware Compatibility.

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x30
[4]	0x31
[5-10]	0x00
[11]	Checksum

The SGS replies with 18-bytes:

[0-1]	Magic Number (Unsigned 16-bit) (0x7881)
[2-13]	Serial Number (ASCII characters)
[14-15]	Firmware Version (Unsigned 16-bit)
[16]	Checksum
[17]	Acknowledge (0x32)

3.7.3 Set Sensor Configuration

This command allows to configured the low and high frequency of the sensor bandwidth response to match the desired measurement standard.

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x30
[4]	0x37
[5-10]	0x00
[11]	Checksum

The SGS responds with 1 byte:

[0]	Acknowledge (0x32)
-----	--------------------

The host waits 5ms

The host sends the following 6-bytes configuration:

[0-1]	Magic Number (Unsigned 16-bit) (0x7881)
[2]	Fu Index
[3]	Fo Index
[4]	Enable KBF (0x00: Disable, 0x01: Enable)
[5]	Checksum

The SGS responds with 1 byte:

[0]	Acknowledge (0x32)
-----	--------------------

The available options for "Fu Index", "Fo Index" and "Enable KBF" are determined from the SGS model ID. Refer to section 3.5, Hardware and Firmware Compatibility, for more information.

3.7.4 Get Sensor Configuration

The current sensor configuration can be read back if desired.

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x30
[4]	0x36
[5-10]	0x00
[11]	Checksum

The SGS replies with 7 bytes:

[0-1]	Magic Number (Unsigned 16-bit) (0x7881)
[2]	Fu Index
[3]	Fo Index
[4]	Enable KBF (0x00: Disable, 0x01: Enable)
[5]	Checksum
[6]	Acknowledge (0x32)

3.7.5 Reset Buffer Status

This command is used at the beginning of the acquisition session or when desired to empty the acquisition buffer: 100 blocks of 93ms for both the data and the time signal are erased.

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x30
[4]	0x33
[5-10]	0x00
[11]	Checksum

The SGS replies with 1 byte:

[0]	Acknowledge (0x32)
-----	--------------------

3.7.6 Get Buffer Status

This command is used to determine the number of blocks in the buffer for both the Data and Waveform. Each block has a duration of 93ms and there are 100 blocks in the buffer for a total of 9.3s.

The buffer status indicates the quantity of blocks available in the buffer as well as the ID of the last block in the buffer.

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x30
[4]	0x32
[5-10]	0x00
[11]	Checksum

The SGS replies with 18-bytes:

[0-3]	Buffer Number of Blocks (Unsigned 32-bit)
[4-11]	Reserved
[12-15]	Buffer Last Block ID (Unsigned 32-bit)
[16]	Checksum
[17]	Acknowledge (0x32)

3.7.7 Get Data

Without 1/3 Octave Band Spectrum

This command allows to get a specific instant data block of 93ms in the sensor buffer without the 1/3 octave data. This command is useful to monitor the peak value to trig a time signal recording.

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x32
[4]	0x30
[5-8]	Block ID (Unsigned 32-bit)
[9-10]	0x00
[11]	Checksum

The SGS replies with 58 bytes:

[0-3]	Block ID (Unsigned 32-bit)
[4-7]	RMS, X, m/s (Float 32-bit)
[8-11]	RMS, Y, m/s (Float 32-bit)
[12-15]	RMS, Z, m/s (Float 32-bit)
[16-19]	RMS, Vector Sum, m/s (Float 32-bit)
[20-23]	Peak, X, m/s (Float 32-bit)
[24-27]	Peak, Y, m/s (Float 32-bit)
[28-31]	Peak, Z, m/s (Float 32-bit)
[32-35]	Peak, Vector Sum, m/s (Float 32-bit)
[36-39]	KBFmax, X, m/s (Float 32-bit)
[40-43]	KBFmax, Y, m/s (Float 32-bit)
[44-47]	KBFmax, Z, m/s (Float 32-bit)
[48-51]	KBFmax, Vector Sum, m/s (Float 32-bit)
[52]	Status, X (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[53]	Status, Y (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[54]	Status, Z (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[55]	Status, Vector Sum (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[56]	Checksum

[57] Acknowledge (0x32)

With 1/3 Octave Band Spectrum

This command allows to get a specific instant data block of 93ms in the sensor buffer.

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x30
[4]	0x34
[5-8]	Block ID (Unsigned 32-bit)
[9-10]	0x00
[11]	Checksum

The SGS replies with 1018 bytes:

[0-3]	Block ID (Unsigned 32-bit)
[4-7]	RMS, X, m/s (Float 32-bit)
[8-11]	RMS, Y, m/s (Float 32-bit)
[12-15]	RMS, Z, m/s (Float 32-bit)
[16-19]	RMS, Vector Sum, m/s (Float 32-bit)
[20-23]	Peak, X, m/s (Float 32-bit)
[24-27]	Peak, Y, m/s (Float 32-bit)
[28-31]	Peak, Z, m/s (Float 32-bit)
[32-35]	Peak, Vector Sum, m/s (Float 32-bit)
[36-39]	KBFmax, X, m/s (Float 32-bit)
[40-43]	KBFmax, Y, m/s (Float 32-bit)
[44-47]	KBFmax, Z, m/s (Float 32-bit)
[48-51]	KBFmax, Vector Sum, m/s (Float 32-bit)
[52]	Status, X (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[53]	Status, Y (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[54]	Status, Z (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[55]	Status, Vector Sum (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[56-175]	Spectrum, RMS, X, m/s (30x Float 32-bit)
[176-295]	Spectrum, RMS, Y, m/s (30x Float 32-bit)
[296-415]	Spectrum, RMS, Z, m/s (30x Float 32-bit)

[416-535]	Spectrum, Peak, X, m/s (30x Float 32-bit)
[536-655]	Spectrum, Peak, Y, m/s (30x Float 32-bit)
[656-775]	Spectrum, Peak, Z, m/s (30x Float 32-bit)
[776-895]	Spectrum, RMS, Vector Sum, m/s (30x Float 32-bit)
[896-1015]	Spectrum, Peak, Vector Sum, m/s (30x Float 32-bit)
[1016]	Checksum
[1017]	Acknowledge (0x32)

3.7.8 Get Waveform

This command allows to get a specific instant time signal block of 93ms in the sensor buffer.

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x30
[4]	0x35
[5-8]	Block ID (Unsigned 32-bit)
[9-10]	0x00
[11]	Checksum

The SGS replies with 1558 bytes:

[0-3]	Block ID (Unsigned 32-bit)
[4]	Status, X (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[5]	Status, Y (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[6]	Status, Z (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[7]	Status, Vector Sum (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[8-11]	Scaling factor, X (Float, 32-bit)
[12-15]	Scaling factor, Y (Float, 32-bit)
[16-19]	Scaling factor, Z (Float, 32-bit)
[20-531]	Waveform, X (256x Signed 16-bit)
[532-1043]	Waveform, Y (256x Signed 16-bit)
[1044-1555]	Waveform, Z (256x Signed 16-bit)
[1556]	Checksum
[1557]	Acknowledge (0x32)

Multiply the "Scaling Factor" (Float 32-bit) with the digital waveform values (Signed 16-bit) to represent the waveform in m/s.

3.7.9 Get Combined Data and Waveform

This command offers a combined packet for commands Get Data and Get Waveform where acquisition is critical.

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x31
[4]	0x38
[5-8]	Block ID (Unsigned 32-bit)
[9-10]	0x00
[11]	Checksum

The SGS replies with 2574 bytes:

[0-1015]	Payload from the Get Data command
[1016-2571]	Payload from the Get Waveform command
[2572]	Checksum
[2573]	Acknowledge (0x32)

3.7.10 Get/Reset Average Data

The SGS automatically computes an average. The same function is used to read the accumulated data and reset the average.

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x31
[4]	0x39
[5-10]	0x00
[11]	Checksum

The SGS replies with 1550 bytes and resets the average:

[0-3]	Peak, X, m/s (Float 32-bit)
-------	-----------------------------

[4-7]	Peak, Y, m/s (Float 32-bit)
[8-11]	Peak, Z, m/s (Float 32-bit)
[12-15]	ZC Frequency, X, Hz (Float 32-bit)
[16-19]	ZC Frequency, Y, Hz (Float 32-bit)
[20-23]	ZC Frequency, Z, Hz (Float 32-bit)
[24-27]	Time of Peak, X, s (Float 32-bit)
[28-31]	Time of Peak, Y, s (Float 32-bit)
[32-35]	Time of Peak, Z, s (Float 32-bit)
[36-39]	Average Duration, s (Float 32-bit)
[40-43]	RMS, X, m/s (Float 32-bit)
[44-47]	RMS, Y, m/s (Float 32-bit)
[48-51]	RMS, Z, m/s (Float 32-bit)
[52-55]	RMS, Vector Sum, m/s (Float 32-bit)
[56-59]	Peak, X, m/s (Float 32-bit)
[60-63]	Peak, Y, m/s (Float 32-bit)
[64-67]	Peak, Z, m/s (Float 32-bit)
[68-71]	Peak, Vector Sum, m/s (Float 32-bit)
[72-75]	KBFmax, X, m/s (Float 32-bit)
[76-79]	KBFmax, Y, m/s (Float 32-bit)
[80-83]	KBFmax, Z, m/s (Float 32-bit)
[84-87]	KBFmax, Vector Sum, m/s (Float 32-bit)
[88]	Status, X (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[89]	Status, Y (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[90]	Status, Z (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[91]	Status, Vector Sum (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[92-211]	Spectrum, RMS, X, m/s (30x Float 32-bit)
[212-331]	Spectrum, RMS, Y, m/s (30x Float 32-bit)
[332-451]	Spectrum, RMS, Z, m/s (30x Float 32-bit)
[452-571]	Spectrum, Peak, X, m/s (30x Float 32-bit)
[572-691]	Spectrum, Peak, Y, m/s (30x Float 32-bit)
[692-811]	Spectrum, Peak, Z, m/s (30x Float 32-bit)
[812-931]	Spectrum, RMS, Vector Sum, m/s (30x Float 32-bit)
[932-1051]	Spectrum, Peak, Vector Sum, m/s (30x Float 32-bit)
[1052-1055]	RMSmax, X, m/s (Float 32-bit)
[1056-1059]	RMSmax, Y, m/s (Float 32-bit)
[1060-1063]	RMSmax, Z, m/s (Float 32-bit)
[1064-1067]	RMSmax, Vector Sum, m/s (Float 32-bit)
[1068-1187]	Spectrum, RMSmax, X, m/s (30x Float 32-bit)

[1188-1307]	Spectrum, RMSmax, Y, m/s (30x Float 32-bit)
[1308-1427]	Spectrum, RMSmax, Z, m/s (30x Float 32-bit)
[1428-1547]	Spectrum, RMSmax, Vector Sum, m/s (30x Float 32-bit)
[1548]	Checksum
[1549]	Acknowledge (0x32)

3.7.11 Exec Sensor-Check

This command executes a sensor-check on the SGS.

The sensor-check performs a step-response of each geophone element and records the resulting waveform in its non-volatile memory.

The sensor-check response is compared to a factory reference response for compliance assessment.

The host must provide the current Unix time reference in the command for the SGS to add the time reference to the sensor-check.

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x31
[4]	0x30
[5-10]	Unix Time Reference (Unsigned 64-bit, least significant 6 bytes)
[11]	Checksum

The SGS replies with an acknowledge byte after about 3s when the sensor-check is completed:

[0]	Acknowledge (0x32)
-----	--------------------

3.7.12 Get Sensor-Check

This command allows to read the sensor-check result from the SGS non-volatile memory. The host can either read the last sensor-check performed by the host, or the factory default.

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x31

[4]	0x31
[5-9]	0x00
[10]	0x00: read user sensor-check, 0x01: read factory reference sensor-check
[11]	Checksum

The SGS replies with 2460 bytes:

[0-1]	Magic Number (Unsigned 16-bit) (0x7881)
[2-9]	Unix Time Reference (Unsigned 64-bit)
[10-13]	Peak, X, m/s (Float 32-bit)
[14-17]	Peak, Y, m/s (Float 32-bit)
[18-21]	Peak, Z, m/s (Float 32-bit)
[22-25]	ZC Frequency, X, Hz (Float 32-bit)
[26-29]	ZC Frequency, Y, Hz (Float 32-bit)
[30-33]	ZC Frequency, Z, Hz (Float 32-bit)
[34-37]	Time of Peak, X, s (Float 32-bit)
[38-41]	Time of Peak, Y, s (Float 32-bit)
[42-45]	Time of Peak, Z, s (Float 32-bit)
[46-49]	Average Duration, s (Float 32-bit)
[50]	Status, X (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[51]	Status, Y (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[52]	Status, Z (Unsigned 8-bit) (Bit0: Reserved, Bit1: Overload, Bit2: Not UnderRange)
[53-56]	Reference Peak, X, m/s (Float 32-bit)
[57-60]	Reference Peak, Y, m/s (Float 32-bit)
[61-64]	Reference Peak, Z, m/s (Float 32-bit)
[65-68]	Tolerance, X, m/s (Float 32-bit)
[69-72]	Tolerance, Y, m/s (Float 32-bit)
[73-76]	Tolerance, Z, m/s (Float 32-bit)
[77]	Compliance, X (0x00: Fail, 0x01: Pass)
[78]	Compliance, Y (0x00: Fail, 0x01: Pass)
[79]	Compliance, Z (0x00: Fail, 0x01: Pass)
[80-81]	Number of waveform blocks (Unsigned 16-bit, 0x06)
[82-85]	Scaling factor, X (Float, 32-bit)
[86-89]	Scaling factor, Y (Float, 32-bit)
[90-93]	Scaling factor, Z (Float, 32-bit)
[94-221]	Waveform, X (128x Signed 8-bit)
[222-349]	Waveform, Y (128x Signed 8-bit)
[350-477]	Waveform, Z (128x Signed 8-bit)
[478-873]	Waveform block 1 (use same definition as bytes 82 to 477)

- [874-1269] Waveform block 2 (use same definition as bytes 82 to 477)
- [1270-1665] Waveform block 3 (use same definition as bytes 82 to 477)
- [1666-2061] Waveform block 4 (use same definition as bytes 82 to 477)
- [2062-2457] Waveform block 5 (use same definition as bytes 82 to 477)
- [2458] Checksum
- [2459] Acknowledge (0x32)

3.7.13 Get Tilt

The availability of the tilt sensor is determined from the SGS model ID. Refer to section 3.5, Hardware and Firmware Compatibility, for more information.

This command allows to get the X, Y and Z gravity in g, as measured by an on-board MEMS accelerometer. This information is useful to determine the tilt of the SGS.

The host sends the following 12-bytes command:

- [0] 0x41
- [1] 0x50
- [2] 0x50
- [3] 0x32
- [4] 0x32
- [5-10] 0x00
- [11] Checksum

The SGS replies after about 3s with 14 bytes:

- [0-3] Gravity, X, g (Float, 32-bit)
- [4-7] Gravity, Y, g (Float, 32-bit)
- [8-11] Gravity, Z, g (Float, 32-bit)
- [12] Checksum
- [13] Acknowledge (0x32)

The tilt against the Z axis can be determined using the following trigonometry equation:

```
vertical = gravityZ;
horizontal = sqrt(gravityX^2 + gravityY^2);
tilt = atan(horizontal / vertical);
```

3.7.14 Get Temperature

This command allows to obtain the current SGS temperature in Celsius. The protocol sequence is:

The host sends the following 12-bytes command:

[0]	0x41
[1]	0x50
[2]	0x50
[3]	0x30
[4]	0x39
[5-11]	0x00
[11]	Checksum

The SGS replies with 6 bytes:

[0-3]	Temperature, °C (Float 32-bit)
[4]	Checksum
[5]	Acknowledge (0x32)

3.7.15 Reset Device

This command can be used to make a software reset of the SGS.

The host sends the following 12-bytes command:

[0]	0x42
[1]	0x6F
[2]	0x61
[3]	0x72
[4]	0x64
[5]	0x52
[6]	0x65
[7]	0x73
[8]	0x65
[9]	0x74
[10]	0x2D
[11]	Checksum

The SGS does not reply to this command and will be ready for a new command after about 2s.