

LPMS-ME1

User Manual ver. 2.0



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Revisions

| Date | Version | Changes |
|-------------------|-----------|---|
| 2019-11-22 | ver. 2.0 | <ul style="list-style-type: none">remove hardware information to the hardware manual, and rename the file to user manualadd the information of SPI |
| 2017-10-02 | ver. 1.12 | <ul style="list-style-type: none">to change the file name of this document from Datasheet to Manual |
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1. Introduction

The LPMS-ME1 is a low cost, high performance inertial measurement unit (IMU) with 9-axis. It integrates multiple sensors including 3-axis accelerometer, 3-axis gyroscope and 3-axis magnetometer. After the correction and calculation through the unique algorithm of our company, it can provide precise data including Euler angles, quaternion and linear acceleration. In the meanwhile, the size of LPMS-ME1 is very small, which means it is easy to assemble, convenient for you to embed it in your system and good for your design and development.

Key Features:

- MEMS miniature inertial measurement unit (IMU)
- Integration of 3-axis gyroscope, accelerometer and magnetometer in one unit
- Real-time, on-device calculation of sensor orientation and linear acceleration
- Power Supply: 3.3~5.5V
- Interfaces: UART, I2C, SPI
- Size: PLCC-28 (12.0x12.0x2.6mm)

Applications:

- Human motion capture
- Internet of Things (IOT) devices
- Sports performance evaluation
- Drone fight control



2. Communication Protocol

2.1 LPBUS Protocol

LPBUS is a communication protocol based on the industry standard MODBUS protocol. It is the default communication format used by LPMS devices.

An LPBUS communication packet has two basic command types, GET and SET, that are sent from a host (PC, mobile data logging unit etc.) to a client (LPMS device). Later in this manual we will show a description of all supported commands to the sensor, their type and transported data.

GET Commands: Data from the client is read using GET requests. A GET request usually contains no data. The answer from the client to a GET request contains the requested data.

SET Commands: Data registers of the client are written using SET requests. A SET command from the host contains the data to be set. The answer from the client is either ACK (acknowledged) for a successful write, or NACK (not acknowledged) for a failure to set the register occurred.

Notes: Please refer to the Appendix for detailed command lists.

2.2 Communication Modes

LPMS devices have two communication modes including Streaming Mode and Command Mode.

In streaming mode, a LPMS device keeps transmitting measurement data at a preset frequency.

In command mode, a LPMS device is communicated by sending commands, which can be used to set up the parameters and get measurement data of the device.

The default communication mode of LPMS-ME1 is streaming mode when powered up. (The default output data rate is 100 Hz; and please refer to Table 2-3 for the default transmitted data types.)

Figure 2.1 shows the flowchart for changing the parameters of LPMS devices.

Notes:

- Only 4 commands are executable in streaming mode, see **Figure 2.1**.
- Command **WRITE_REGISTERS** must be executed after changing sensor parameters, or all changes fail to set up after power down, see **Step 4 in Figure 2.1**.

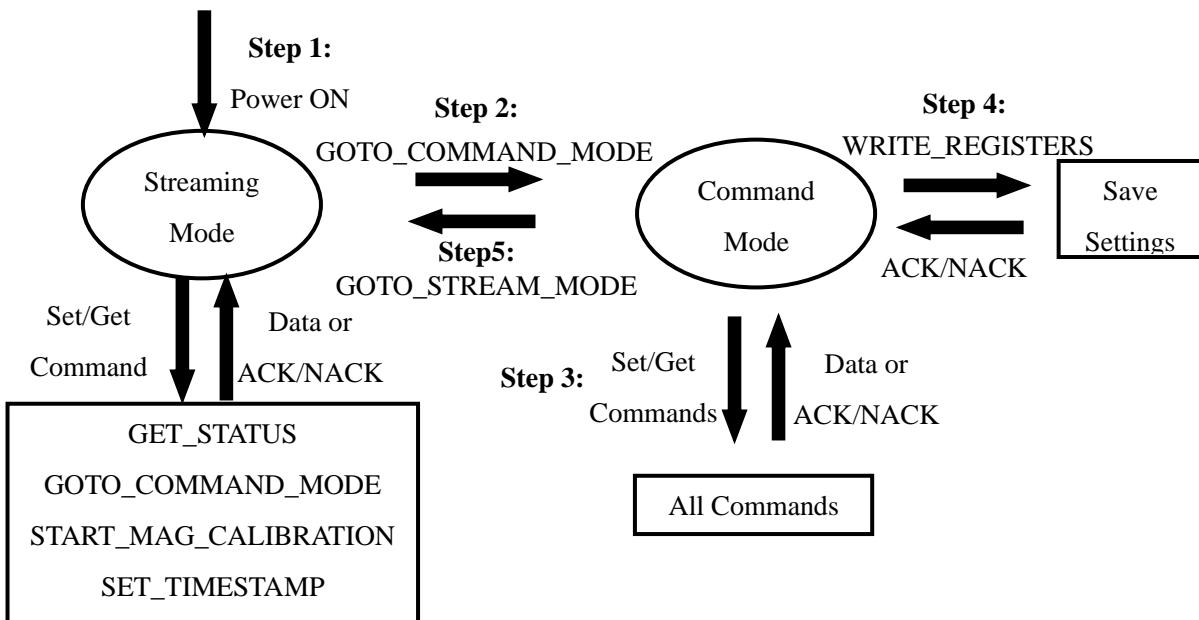


Figure 2.1. Flowchart of sensor parameters setting

2.3 LPBUS Packet Structure

Table 2-1 LPBUS Packet Structure

| Byte# | Name | Description |
|-------|---------------------------|--|
| 0 | Packet start | 3Ah |
| 1 | Sensor ID byte 1 | Low byte of the Sensor ID to be communicated with. The default value of sensor ID is 1. A host can send out a GET / SET request to the sensor by using relative sensor ID, and the client answers to request also with the same ID. This ID can be adjusted by sending a SET command to the sensor. |
| 2 | Sensor ID byte 2 | High byte of the Sensor ID. |
| 3 | Command # byte 1 | Low byte of the command number. |
| 4 | Command # byte 2 | High byte of the command number. |
| 5 | Packet data length byte 1 | Low byte of the packet data length in bytes. |
| 6 | Packet data length byte 2 | High byte of the packet data length in bytes. |
| x | Packet data (n bytes) | If packet data length n not equal to zero, x = 6+1, 6+2...6+n . Otherwise x = none , the data field is empty. |



| | | |
|-------------|--------------------|--|
| 7+n | LRC byte 1 | Low byte of LRC check-sum. LRC is calculated in the following way: LRC = sum(Packet Byte#1 to #x) |
| 8+n | LRC byte 2 | High byte of LRC check-sum. |
| 9+n | Termination byte 1 | 0Dh |
| 10+n | Termination byte 2 | 0Ah |

The Packet data is sent in **little-endian format**, low order byte first, high order byte last.
There are two types of data format for the packet data:

- 32-bit float
- 16-bit integer

In default setting, sensor data is in 32-bit float format (except timestamp, always 32-bit integer), Table 2-2 shows the data format and order of each sensor data type inside a packet. Please refer to Table 2-5 for the definition of each data format identifier.

Table 2-2 Data Format in 32-bit Float Data Transmission Mode

| Chunk# | Format identifier | Sensor data type |
|----------|-------------------|---|
| 1 | UInt32 | Timestamp counter. (400Hz update rate, 0.0025s) |
| 2 | Vector3f | Calibrated gyroscope data (rad/s) |
| 3 | Vector3f | Calibrated accelerometer data (g) |
| 4 | Vector3f | Calibrated magnetometer data (μ T) |
| 5 | Vector3f | Angular velocity (rad/s) |
| 6 | Vector4f | Orientation quaternion (normalized) |
| 7 | Vector3f | Euler angle data (rad) |
| 8 | Vector3f | Linear acceleration data (g) |

If users change the sensor setting to 16-bit integer data transmission mode, data values are transmitted to the host with pre-scale factor in order to increase precision. Table 2-3 shows the data format, sensor data order and relative pre-scale factor in 16-bit data transmission mode.

Table 2-3 Data Format in 16-bit Integer Data Transmission Mode

| Chunk# | Data type | Sensor data type | Factor |
|----------|------------|--|--------|
| 1 | UInt32 | Timestamp counter (400Hz update rate, 0.0025s) | none |
| 2 | Vector3i16 | Calibrated gyroscope data (rad/s) | 1000 |
| 3 | Vector3i16 | Calibrated accelerometer data (g) | 1000 |
| 4 | Vector3i16 | Calibrated magnetometer data (μ T) | 100 |
| 5 | Vector3i16 | Angular velocity (rad/s) | 1000 |



| | | | |
|----------|------------|-------------------------------------|-------|
| 6 | Vector4i16 | Orientation quaternion (normalized) | 10000 |
| 7 | Vector3i16 | Euler angle data (rad) | 10000 |
| 8 | Vector3i16 | Linear acceleration data (g) | 1000 |

Table 2-4 Data Format Identifier Definition

| Identifier | Description |
|-------------------|--|
| UInt32 | 32-bit unsigned integer value |
| Int32 | 32-bit signed integer value |
| Int16 | 16-bit signed integer value |
| Float32 | 32-bit float value |
| Vector3f | 3 element 32-bit float vector |
| Vector3i16 | 3 element 16-bit signed integer vector |
| Vector4f | 4 element 32-bit float vector |
| Vector4i16 | 4 element 16-bit signed integer vector |
| Matrix3x3f | 3x3 element float value matrix |

The sensor data is sent at the order showed in Table 2-2 and Table 2-3, totally 8 types of data from #1 to #8. The timestamp data is a fixed output which cannot be disabled by users. The data output of types from #2 to #8 can be enabled or disabled by users. If there is any data type is disabled, the following data type will be rolled forwards.

In default setting, the sensor outputs the following data in order (total 7 types of data):

1. Timestamp
2. Calibrated gyroscope data
3. Calibrated accelerometer data
4. Calibrated magnetometer data
5. Orientation quaternion
6. Euler angle data
7. Linear acceleration data



2.4 Communication Examples

In this section we will show a few communication examples using LPBUS protocol.

Go to Command Mode

(HOST -> SENSOR)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 06h | Command no. LSB (GOTO_COMMAND_MODE = 06h) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (GOTO_COMMAND_MODE command = no data) |
| 6 | 00h | Data length MSB |
| 7 | 07h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Reply data (SENSOR -> HOST)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 00h | Command no. LSB (REPLY_ACK=00h) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (REPLY_ACK reply = no data) |
| 6 | 00h | Data length MSB |
| 7 | 01h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |



Go to Streaming Mode

(HOST -> SENSOR)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 07h | Command no. LSB (07h = GOTO_STREAMING_MODE) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (GOTO_STREAMING_MODE command = no data) |
| 6 | 00h | Data length MSB |
| 7 | 08h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Reply data (SENSOR -> HOST)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 00h | Command no. LSB (0d = REPLY_ACK) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (REPLY_ACK reply = no data) |
| 6 | 00h | Data length MSB |
| 7 | 01h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |



Get Sensor Configuration

Get request (HOST -> SENSOR)

| Packet byte no. | Content | Meaning |
|-----------------|---------|--|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 04h | Command no. LSB (04h = GET_CONFIG) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (GET_CONFIG command = no data) |
| 6 | 00h | Data length MSB |
| 7 | 05h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Reply data (SENSOR -> HOST)

| Packet byte no. | Content | Meaning |
|-----------------|---------|--|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 04h | Command no. LSB (04h = GET_CONFIG) |
| 4 | 00h | Command no. MSB |
| 5 | 04h | Data length LSB (32-bit integer = 4 bytes) |
| 6 | 00h | Data length MSB |
| 7 | xxh | Configuration data byte 1 (LSB) |
| 8 | xxh | Configuration data byte 2 |
| 9 | xxh | Configuration data byte 3 |
| 10 | xxh | Configuration data byte 4 (MSB) |
| 11 | xxh | Check sum LSB |
| 12 | xxh | Check sum MSB |
| 13 | 0Dh | Packet end 1 |
| 14 | 0Ah | Packet end 2 |

Note: xx = Value depends on the current sensor configuration.



Get Gyroscope Range

Get request (HOST -> SENSOR)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 1Ah | Command no. LSB (1Ah = GET_GYR_RANGE) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (GET_GYR_RANGE command = no data) |
| 6 | 00h | Data length MSB |
| 7 | 1Bh | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Reply data (SENSOR -> HOST)

| Packet byte no. | Content | Meaning |
|-----------------|---------|--|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 1Ah | Command no. LSB (1Ah = GET_GYR_RANGE) |
| 4 | 00h | Command no. MSB |
| 5 | 04h | Data length LSB (32-bit integer = 4 bytes) |
| 6 | 00h | Data length MSB |
| 7 | xxh | Range data byte 1 (LSB) |
| 8 | xxh | Range data byte 2 |
| 9 | xxh | Range data byte 3 |
| 10 | xxh | Range data byte 4 (MSB) |
| 11 | xxh | Check sum LSB |
| 12 | xxh | Check sum MSB |
| 13 | 0Dh | Packet end 1 |
| 14 | 0Ah | Packet end 2 |

Note: xx = Value depends on the current sensor configuration.



Set Accelerometer Range

Set request (HOST -> SENSOR)

| Packet byte no. | Content | Meaning |
|-----------------|---------|--|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 1Fh | Command no. LSB (1Fh = SET_ACC_RANGE) |
| 4 | 00h | Command no. MSB |
| 5 | 04h | Data length LSB (32-bit integer = 4 bytes) |
| 6 | 00h | Data length MSB |
| 7 | 08h | Range data byte 1 (Range indicator 8g = 08h) |
| 8 | 00h | Range data byte 2 |
| 9 | 00h | Range data byte 3 |
| 10 | 00h | Range data byte 4 |
| 11 | 2Ch | Check sum LSB |
| 12 | 00h | Check sum MSB |
| 13 | 0Dh | Packet end 1 |
| 14 | 0Ah | Packet end 2 |

Reply data (SENSOR -> HOST)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 00h | Command no. LSB (00h = REPLY_ACK) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (REPLY_ACK reply = no data) |
| 6 | 00h | Data length MSB |
| 7 | 01h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |



Get Sensor Data

Get request (HOST -> SENSOR)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 09h | Command no. LSB (09h = GET_SENSOR_DATA) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (GET_SENSOR_DATA command = no data) |
| 6 | 00h | Data length MSB |
| 7 | 0Ah | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Reply data (SENSOR -> HOST), 32-bit float data format

| Packet byte no. | Content | Meaning |
|-----------------|-----------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 09h | Command no. LSB (09h = GET_SENSOR_DATA) |
| 4 | 00h | Command no. MSB |
| 5 | 50h | Data length LSB (50h = 80 bytes) |
| 6 | 00h | Data length MSB |
| 7-10 | xxxxxxxxh | Timestamp |
| 11-14 | xxxxxxxxh | Gyroscope data x-axis |
| 15-18 | xxxxxxxxh | Gyroscope data y-axis |
| 19-22 | xxxxxxxxh | Gyroscope data z-axis |
| 23-26 | xxxxxxxxh | Accelerometer x-axis |
| 27-30 | xxxxxxxxh | Accelerometer y-axis |
| 31-34 | xxxxxxxxh | Accelerometer z-axis |
| 35-38 | xxxxxxxxh | Magnetometer x-axis |
| 39-42 | xxxxxxxxh | Magnetometer y-axis |
| 43-46 | xxxxxxxxh | Magnetometer z-axis |



| | | |
|--------------|-----------|----------------------------|
| 47-50 | xxxxxxxxh | Orientation quaternion q0 |
| 51-54 | xxxxxxxxh | Orientation quaternion q1 |
| 55-58 | xxxxxxxxh | Orientation quaternion q2 |
| 59-62 | xxxxxxxxh | Orientation quaternion q3 |
| 63-66 | xxxxxxxxh | Euler angles x-axis |
| 67-70 | xxxxxxxxh | Euler angles y-axis |
| 71-74 | xxxxxxxxh | Euler angles z-axis |
| 75-78 | xxxxxxxxh | Linear acceleration x-axis |
| 79-82 | xxxxxxxxh | Linear acceleration y-axis |
| 83-86 | xxxxxxxxh | Linear acceleration z-axis |
| 87 | xxh | Check sum LSB |
| 88 | xxh | Check sum MSB |
| 89 | 0Dh | Packet end 1 |
| 90 | 0Ah | Packet end 2 |

Notes:**1. The reply data above is in default setting.****2. xx = Value depends on the current configuration and measurement value.**

If only accelerometer and quaternion data are enabled, reply data will be like the following.

| Packet byte no. | Content | Meaning |
|-----------------|-----------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 09h | Command no. LSB (09h = GET_SENSOR_DATA) |
| 4 | 00h | Command no. MSB |
| 5 | 20h | Data length LSB (20h = 32 bytes) |
| 6 | 00h | Data length MSB |
| 7-10 | xxxxxxxxh | Timestamp |
| 11-14 | xxxxxxxxh | Accelerometer x-axis |
| 15-18 | xxxxxxxxh | Accelerometer y-axis |
| 19-22 | xxxxxxxxh | Accelerometer z-axis |
| 23-26 | xxxxxxxxh | Orientation quaternion q0 |
| 27-30 | xxxxxxxxh | Orientation quaternion q1 |
| 31-34 | xxxxxxxxh | Orientation quaternion q2 |
| 35-38 | xxxxxxxxh | Orientation quaternion q3 |



| | | |
|-----------|-----|---------------|
| 39 | xxh | Check sum LSB |
| 40 | xxh | Check sum MSB |
| 41 | 0Dh | Packet end 1 |
| 42 | 0Ah | Packet end 2 |

Save Settings to Sensor

Get request (HOST -> SENSOR)

| Packet byte no. | Content | Meaning |
|------------------------|----------------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 0Fh | Command no. LSB (0Fh = WRITE_REGISTERS) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (WRITE_REGISTERS command = no data) |
| 6 | 00h | Data length MSB |
| 7 | 10h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Reply data (SENSOR -> HOST)

| Packet byte no. | Content | Meaning |
|------------------------|----------------|---------------------------------------|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 00h | Command no. LSB (00h = REPLY_ACK) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (ACK reply = no data) |
| 6 | 00h | Data length MSB |
| 7 | 01h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Note: This command needs about 1~2s to get the reply data.



Get Sensor Status

Get request (HOST -> SENSOR)

| Packet byte no. | Content | Meaning |
|-----------------|---------|--|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 05h | Command no. LSB (05h = GET_STATUS) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (GET_STATUS command = no data) |
| 6 | 00h | Data length MSB |
| 7 | 06h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Reply data (SENSOR -> HOST)

| Packet byte no. | Content | Meaning |
|-----------------|-----------|--|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 05h | Command no. LSB (05h = GET_STATUS) |
| 4 | 00h | Command no. MSB |
| 5 | 04h | Data length LSB (32-bit integer = 4 bytes) |
| 6 | 00h | Data length MSB |
| 7-10 | xxxxxxxxh | Status data |
| 11 | xxh | Check sum LSB |
| 12 | xxh | Check sum MSB |
| 13 | 0Dh | Packet end 1 |
| 14 | 0Ah | Packet end 2 |

Note: Please refer to Appendix for the introduction of status register.



Gyroscope Calibration

Get request (HOST -> SENSOR)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 16h | Command no. LSB (16h = START_GYR_CALIBRATION) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (START_GYR_CALIBRATION command = no data) |
| 6 | 00h | Data length MSB |
| 7 | 17h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Reply data (SENSOR -> HOST)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---------------------------------------|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 00h | Command no. LSB (00h = REPLY_ACK) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (ACK reply = no data) |
| 6 | 00h | Data length MSB |
| 7 | 01h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Notes:

After sending this command, a ACK reply indicates a start of gyroscope calibration. During calibration, sensor has to be held still for about 10s. The calibration status can be checked by sending command GET_STATUS (Bit3 of the int32 reply data is for Gyroscope calibration status. "1" indicates calibration running while it is cleared by hardware after calibration finished).



Magnetometer Calibration

Get request (HOST -> SENSOR)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 11h | Command no. LSB (11h = START_MAG_CALIBRATION) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (START_MAG_CALIBRATION command = no data) |
| 6 | 00h | Data length MSB |
| 7 | 12h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Reply data (SENSOR -> HOST)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---------------------------------------|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 00h | Command no. LSB (00h = REPLY_ACK) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (ACK reply = no data) |
| 6 | 00h | Data length MSB |
| 7 | 01h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Notes:

This command is similar to gyroscope calibration command, a ACK reply indicates a start of calibration for about 10s. During calibration, sensor needs to be rotated around x, y and z axis continuously so as to create a map of environment magnetic field. You can also use command GET_STATUS for calibration status check (Bit 4 of reply data).



Set UART Baud Rate

Set request (HOST -> SENSOR)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 54h | Command no. LSB (54h = SET_UART_BAUDRATE) |
| 4 | 00h | Command no. MSB |
| 5 | 04h | Data length LSB (32-bit integer = 4 bytes) |
| 6 | 00h | Data length MSB |
| 7 | 07h | Set UART baud rate = 921600 bps; Please refer to Command “SET_UART_BAUDRATE” in Appendix for details. |
| 8 | 00h | |
| 9 | 00h | |
| 10 | 00h | |
| 11 | 60h | Check sum LSB |
| 12 | 00h | Check sum MSB |
| 13 | 0Dh | Packet end 1 |
| 14 | 0Ah | Packet end 2 |

Reply data (SENSOR -> HOST)

| Packet byte no. | Content | Meaning |
|-----------------|---------|---------------------------------------|
| 0 | 3Ah | Packet start |
| 1 | 01h | Sensor ID LSB (ID = 1) |
| 2 | 00h | Sensor ID MSB |
| 3 | 00h | Command no. LSB (0d = REPLY_ACK) |
| 4 | 00h | Command no. MSB |
| 5 | 00h | Data length LSB (ACK reply = no data) |
| 6 | 00h | Data length MSB |
| 7 | 01h | Check sum LSB |
| 8 | 00h | Check sum MSB |
| 9 | 0Dh | Packet end 1 |
| 10 | 0Ah | Packet end 2 |

Note: The new Baudrate setting will be activated from the next power on



3. Appendix

Summary

| Acknowledged / Not-acknowledged Identifiers | | | | |
|--|-------------|------------------|-----------------|----------------|
| Identifier | Name | Parameter | Response | Default |
| 0 | REPLY_ACK | | | |
| 1 | REPLY_NACK | | | |

| Get Configuration and Status Info Commands | | | | |
|---|-------------------------|------------------|-----------------|----------------|
| Identifier | Name | Parameter | Response | Default |
| 4 (04h) | GET_CONFIG | NONE | Int32 | |
| 5 (05h) | GET_STATUS ¹ | NONE | Int32 | |

| Mode Switching Commands | | | | |
|--------------------------------|--------------------------------|------------------|-----------------|----------------|
| Identifier | Name | Parameter | Response | Default |
| 6 (06h) | GOTO_COMMAND_MODE ¹ | NONE | ACK/NACK | |
| 7 (07h) | GOTO_STREAM_MODE | NONE | ACK/NACK | |

| IMU ID Settings Command | | | | |
|--------------------------------|-------------|------------------|-----------------|----------------|
| Identifier | Name | Parameter | Response | Default |
| 20 (14h) | SET_IMU_ID | Int32 | ACK/NACK | |
| 21 (15h) | GET_IMU_ID | NONE | Int32 | 1 |

| Gyroscope Settings Command | | | | |
|-----------------------------------|-----------------------|------------------|-----------------|----------------|
| Identifier | Name | Parameter | Response | Default |
| 22 (16h) | START_GYR_CALIBRATION | NONE | ACK/NACK | |
| 25 (19h) | SET_GYR_RANGE | Int32 | ACK/NACK | |
| 26 (1Ah) | GET_GYR_RANGE | NONE | Int32 | 2000dps |

| Accelerometer Settings Command | | | | |
|---------------------------------------|---------------|------------------|-----------------|----------------|
| Identifier | Name | Parameter | Response | Default |
| 31 (1Fh) | SET_ACC_RANGE | Int32 | ACK/NACK | |
| 32 (20h) | GET_ACC_RANGE | NONE | Int32 | 4g |

| Magnetometer Settings Command | | | | |
|--------------------------------------|-------------|------------------|-----------------|----------------|
| Identifier | Name | Parameter | Response | Default |



| | | | | |
|----------|------------------------------------|-------|----------|--------|
| 17 (11h) | START_MAG_CALIBRATION ¹ | NONE | ACK/NACK | |
| 33 (21h) | SET_MAG_RANGE | Int32 | ACK/NACK | |
| 34 (22h) | GET_MAG_RANGE | NONE | Int32 | 8Gauss |

| Data Transmission Commands | | | | |
|----------------------------|----------------------------|-----------|----------|---------|
| Identifier | Name | Parameter | Response | Default |
| 9 (09h) | GET_SENSOR_DATA | NONE | | |
| 10 (0Ah) | SET_TRANSMIT_DATA | Int32 | ACK/NACK | |
| 11 (0Bh) | SET_STREAM_FREQ | Int32 | ACK/NACK | |
| 66 (42h) | SET_TIMESTAMP ¹ | Int32 | ACK/NACK | |
| 84 (54h) | SET_UART_BAUDRATE | Int32 | ACK/NACK | |
| 85 (55h) | GET_UART_BAUDRATE | NONE | Int32 | |

| Register Value Save and Reset Command | | | | |
|---------------------------------------|--------------------------|-----------|----------|---------|
| Identifier | Name | Parameter | Response | Default |
| 15 (0Fh) | WRITE_REGISTERS | NONE | ACK/NACK | |
| 16 (10h) | RESTORE_FACTORY_DEFAULTS | NONE | ACK/NACK | |

| Reference Setting and Offset Reset Command | | | | |
|--|--------------------------|-----------|----------|---------|
| Identifier | Name | Parameter | Response | Default |
| 18 (12h) | SET_ORIENTATION_OFFSET | Int32 | ACK/NACK | |
| 82 (52h) | RESET_ORIENTATION_OFFSET | NONE | ACK/NACK | |

| Filter Settings Command | | | | |
|-------------------------|-------------------|-----------|----------|---------|
| Identifier | Name | Parameter | Response | Default |
| 41(29h) | SET_FILTER_MODE | Int32 | ACK/NACK | |
| 42(2Ah) | GET_FILTER_MODE | NONE | Int32 | 1 |
| 43(2Bh) | SET_FILTER_PRESET | Int32 | ACK/NACK | |
| 44(2Ch) | GET_FILTER_PRESET | NONE | Int32 | 3 |

| Device Info | | | | |
|-------------|-------------------|-----------|----------|---------|
| Identifier | Name | Parameter | Response | Default |
| 90(5Ah) | GET_SERIAL_NUMBER | NONE | Char[24] | |
| 92(5Ch) | GET_FIRMWARE_INFO | NONE | Char[16] | |

¹**Note:** These commands are executable in both streaming mode and command mode. Other commands are executable only when the sensor is in command mode.



Acknowledged and Not-acknowledged Identifiers

| | |
|--------------------|------------------------------------|
| Identifier | 0 |
| Name | REPLY_ACK |
| Description | Confirms a successful SET command. |

| | |
|--------------------|---|
| Identifier | 1 |
| Name | REPLY_NACK |
| Description | Reports an error during processing a SET command. |

Configuration and Status Commands

| Identifier | 4 (0x04) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|---|-----|----------------------------|-------|--|-------|----------|---|----------|----|--|----|---|----|-------------------------------------|----|----------------------------|----|----------|----|----------|----|---------------------------------|----|---------------------------------------|----|---------------------------------------|----|----------|----|----------|----|------------------------------------|----|---------------------------------|----|----------|----|-----------------------------------|----|------------------------------------|----|----------|----|----------|----|----------|----|----------|----|------------------------------------|----|----------|
| Name | GET_CONFIG | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Description | Get the current value of the configuration register of the sensor. The configuration word is read-only. The different parameters are set by their respective SET commands. E.g. SET_TRANSMIT_DATA for defining which data is transmitted from the sensor. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Parameter | NONE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Response: | Int32 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Data format | <table border="1"><thead><tr><th>Bit</th><th>Reported State / Parameter</th></tr></thead><tbody><tr><td>0 - 2</td><td>Stream frequency setting (see SET_STREAM_FREQ)</td></tr><tr><td>3 - 8</td><td>Reserved</td></tr><tr><td>9</td><td>Reserved</td></tr><tr><td>10</td><td>Magnetometer data transmission enabled</td></tr><tr><td>11</td><td>Accelerometer data transmission enabled</td></tr><tr><td>12</td><td>Gyroscope data transmission enabled</td></tr><tr><td>13</td><td>Temperature output enabled</td></tr><tr><td>14</td><td>Reserved</td></tr><tr><td>15</td><td>Reserved</td></tr><tr><td>16</td><td>Angular velocity output enabled</td></tr><tr><td>17</td><td>Euler angle data transmission enabled</td></tr><tr><td>18</td><td>Quaternion orientation output enabled</td></tr><tr><td>19</td><td>Reserved</td></tr><tr><td>20</td><td>Reserved</td></tr><tr><td>21</td><td>Linear acceleration output enabled</td></tr><tr><td>22</td><td>16-bit data output mode enabled</td></tr><tr><td>23</td><td>Reserved</td></tr><tr><td>24</td><td>Magnetometer compensation enabled</td></tr><tr><td>25</td><td>Accelerometer compensation enabled</td></tr><tr><td>26</td><td>Reserved</td></tr><tr><td>27</td><td>Reserved</td></tr><tr><td>28</td><td>Reserved</td></tr><tr><td>29</td><td>Reserved</td></tr><tr><td>30</td><td>Gyroscope auto-calibration enabled</td></tr><tr><td>31</td><td>Reserved</td></tr></tbody></table> | Bit | Reported State / Parameter | 0 - 2 | Stream frequency setting (see SET_STREAM_FREQ) | 3 - 8 | Reserved | 9 | Reserved | 10 | Magnetometer data transmission enabled | 11 | Accelerometer data transmission enabled | 12 | Gyroscope data transmission enabled | 13 | Temperature output enabled | 14 | Reserved | 15 | Reserved | 16 | Angular velocity output enabled | 17 | Euler angle data transmission enabled | 18 | Quaternion orientation output enabled | 19 | Reserved | 20 | Reserved | 21 | Linear acceleration output enabled | 22 | 16-bit data output mode enabled | 23 | Reserved | 24 | Magnetometer compensation enabled | 25 | Accelerometer compensation enabled | 26 | Reserved | 27 | Reserved | 28 | Reserved | 29 | Reserved | 30 | Gyroscope auto-calibration enabled | 31 | Reserved |
| Bit | Reported State / Parameter | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 - 2 | Stream frequency setting (see SET_STREAM_FREQ) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 - 8 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | Magnetometer data transmission enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | Accelerometer data transmission enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Gyroscope data transmission enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | Temperature output enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | Angular velocity output enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | Euler angle data transmission enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | Quaternion orientation output enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | Linear acceleration output enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | 16-bit data output mode enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | Magnetometer compensation enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | Accelerometer compensation enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 26 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 27 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 28 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 29 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | Gyroscope auto-calibration enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



| Identifier | 5 (0x05) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|---|-----|-----------------|---|----------------------|---|---------------------|---|----------|---|-------------------------------|---|----------------------------------|---|---------------------------------|---|-------------------------------------|---|------------------------------------|---|----------|---|------------------------|----|----------------------------|----|---------------------------|----|--------------------|-------|----------|
| Name | GET_STATUS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Description | Get the current value of the status register of the sensor. The status word is read-only | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Parameter | NONE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Response: | Int32 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Data format | <table border="1"><thead><tr><th>Bit</th><th>Indicated state</th></tr></thead><tbody><tr><td>0</td><td>COMMAND mode enabled</td></tr><tr><td>1</td><td>STREAM mode enabled</td></tr><tr><td>2</td><td>Reserved</td></tr><tr><td>3</td><td>Gyroscope calibration running</td></tr><tr><td>4</td><td>Magnetometer calibration running</td></tr><tr><td>5</td><td>Gyroscope initialization failed</td></tr><tr><td>6</td><td>Accelerometer initialization failed</td></tr><tr><td>7</td><td>Magnetometer initialization failed</td></tr><tr><td>8</td><td>Reserved</td></tr><tr><td>9</td><td>Gyroscope unresponsive</td></tr><tr><td>10</td><td>Accelerometer unresponsive</td></tr><tr><td>11</td><td>Magnetometer unresponsive</td></tr><tr><td>12</td><td>Flash write failed</td></tr><tr><td>13-31</td><td>Reserved</td></tr></tbody></table> | Bit | Indicated state | 0 | COMMAND mode enabled | 1 | STREAM mode enabled | 2 | Reserved | 3 | Gyroscope calibration running | 4 | Magnetometer calibration running | 5 | Gyroscope initialization failed | 6 | Accelerometer initialization failed | 7 | Magnetometer initialization failed | 8 | Reserved | 9 | Gyroscope unresponsive | 10 | Accelerometer unresponsive | 11 | Magnetometer unresponsive | 12 | Flash write failed | 13-31 | Reserved |
| Bit | Indicated state | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | COMMAND mode enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | STREAM mode enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Gyroscope calibration running | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Magnetometer calibration running | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Gyroscope initialization failed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Accelerometer initialization failed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Magnetometer initialization failed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | Gyroscope unresponsive | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | Accelerometer unresponsive | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | Magnetometer unresponsive | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Flash write failed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13-31 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Mode Switching Commands

| | |
|--------------------|---|
| Identifier | 6 (0x06) |
| Name | GOTO_COMMAND_MODE |
| Description | Switch to command mode. In command mode the user can issue commands to the firmware to perform calibration, set parameters etc. |
| Parameter | NONE |
| Response: | ACK (success) or NACK (error) |

| | |
|--------------------|--|
| Identifier | 7 (0x07) |
| Name | GOTO_STREAM_MODE |
| Description | Switch to streaming mode. In this mode data is continuously streamed from the sensor, and some commands cannot be performed until the sensor receives the GOTO_COMMAND_MODE command. |
| Parameter | NONE |
| Response: | ACK (success) or NACK (error) |



IMU ID Setting Command

| | |
|--------------------|-------------------------------|
| Identifier | 20 (0x14) |
| Name | SET_IMU_ID |
| Description | Set sensor ID |
| Parameter | Int32 |
| Response: | ACK (success) or NACK (error) |

| | |
|--------------------|---------------|
| Identifier | 21 (0x15) |
| Name | GET_IMU_ID |
| Description | Get sensor ID |
| Parameter | None |
| Response: | Int32 |

Gyroscope Settings Command

| | |
|--------------------|---|
| Identifier | 22 (0x16) |
| Name | START_GYR_CALIBRATION |
| Description | Start the calibration of the gyroscope sensor |
| Parameter | NONE |
| Response: | ACK (success) or NACK (error) |

| Identifier | 25 (0x19) | | | | | | | | | | | | |
|--------------------|--|---------------|------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| Name | SET_GYR_RANGE | | | | | | | | | | | | |
| Description | Set the current range of the gyroscope | | | | | | | | | | | | |
| Parameter | Int32 <table border="1"><thead><tr><th>Range (deg/s)</th><th>Identifier</th></tr></thead><tbody><tr><td>125</td><td>125</td></tr><tr><td>245</td><td>245</td></tr><tr><td>500</td><td>500</td></tr><tr><td>1000</td><td>1000</td></tr><tr><td>2000</td><td>2000</td></tr></tbody></table> | Range (deg/s) | Identifier | 125 | 125 | 245 | 245 | 500 | 500 | 1000 | 1000 | 2000 | 2000 |
| Range (deg/s) | Identifier | | | | | | | | | | | | |
| 125 | 125 | | | | | | | | | | | | |
| 245 | 245 | | | | | | | | | | | | |
| 500 | 500 | | | | | | | | | | | | |
| 1000 | 1000 | | | | | | | | | | | | |
| 2000 | 2000 | | | | | | | | | | | | |
| Response: | ACK (success) or NACK (error) | | | | | | | | | | | | |



| Identifier | 26 (0x1A) | | | | | | | | | | | | |
|--------------------|--|---------------|------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| Name | GET_GYR_RANGE | | | | | | | | | | | | |
| Description | Get current gyroscope range. | | | | | | | | | | | | |
| Parameter | NONE | | | | | | | | | | | | |
| Response: | Int32 <table border="1"><thead><tr><th>Range (deg/s)</th><th>Identifier</th></tr></thead><tbody><tr><td>125</td><td>125</td></tr><tr><td>245</td><td>245</td></tr><tr><td>500</td><td>500</td></tr><tr><td>1000</td><td>1000</td></tr><tr><td>2000</td><td>2000</td></tr></tbody></table> | Range (deg/s) | Identifier | 125 | 125 | 245 | 245 | 500 | 500 | 1000 | 1000 | 2000 | 2000 |
| Range (deg/s) | Identifier | | | | | | | | | | | | |
| 125 | 125 | | | | | | | | | | | | |
| 245 | 245 | | | | | | | | | | | | |
| 500 | 500 | | | | | | | | | | | | |
| 1000 | 1000 | | | | | | | | | | | | |
| 2000 | 2000 | | | | | | | | | | | | |

Accelerometer Settings Command

| Identifier | 31 (0x1F) | | | | | | | | | | |
|--------------------|---|-------|------------|----|---|----|---|----|---|-----|----|
| Name | SET_ACC_RANGE | | | | | | | | | | |
| Description | Set the current range of the accelerometer | | | | | | | | | | |
| Parameter | Int32 <table border="1"><thead><tr><th>Range</th><th>Identifier</th></tr></thead><tbody><tr><td>2g</td><td>2</td></tr><tr><td>4g</td><td>4</td></tr><tr><td>8g</td><td>8</td></tr><tr><td>16g</td><td>16</td></tr></tbody></table> | Range | Identifier | 2g | 2 | 4g | 4 | 8g | 8 | 16g | 16 |
| Range | Identifier | | | | | | | | | | |
| 2g | 2 | | | | | | | | | | |
| 4g | 4 | | | | | | | | | | |
| 8g | 8 | | | | | | | | | | |
| 16g | 16 | | | | | | | | | | |
| Response: | ACK (success) or NACK (error) | | | | | | | | | | |

| Identifier | 32 (0x20) | | | | | | | | | | |
|--------------------|---|-------|------------|----|---|----|---|----|---|-----|----|
| Name | GET_ACC_RANGE | | | | | | | | | | |
| Description | Get the current range of the accelerometer | | | | | | | | | | |
| Parameter | NONE | | | | | | | | | | |
| Response: | Int32 <table border="1"><thead><tr><th>Range</th><th>Identifier</th></tr></thead><tbody><tr><td>2g</td><td>2</td></tr><tr><td>4g</td><td>4</td></tr><tr><td>8g</td><td>8</td></tr><tr><td>16g</td><td>16</td></tr></tbody></table> | Range | Identifier | 2g | 2 | 4g | 4 | 8g | 8 | 16g | 16 |
| Range | Identifier | | | | | | | | | | |
| 2g | 2 | | | | | | | | | | |
| 4g | 4 | | | | | | | | | | |
| 8g | 8 | | | | | | | | | | |
| 16g | 16 | | | | | | | | | | |



Magnetometer Settings Command

| | |
|--------------------|--|
| Identifier | 17 (0x11) |
| Name | START_MAG_CALIBRATION |
| Description | Start the calibration of the magnetometer sensor |
| Parameter | NONE |
| Response: | ACK (success) or NACK (error) |

| | | | | | | | | | | | |
|--------------------|---|--------------|-------------------|----------------|---|----------------|---|-----------------|----|-----------------|----|
| Identifier | 33 (0x21) | | | | | | | | | | |
| Name | SET_MAG_RANGE | | | | | | | | | | |
| Description | Set the current range of the gyroscope | | | | | | | | | | |
| Parameter | Int32 <table border="1"><tr><td>Range</td><td>Identifier</td></tr><tr><td>4 Gauss</td><td>4</td></tr><tr><td>8 Gauss</td><td>6</td></tr><tr><td>12 Gauss</td><td>12</td></tr><tr><td>16 Gauss</td><td>16</td></tr></table> | Range | Identifier | 4 Gauss | 4 | 8 Gauss | 6 | 12 Gauss | 12 | 16 Gauss | 16 |
| Range | Identifier | | | | | | | | | | |
| 4 Gauss | 4 | | | | | | | | | | |
| 8 Gauss | 6 | | | | | | | | | | |
| 12 Gauss | 12 | | | | | | | | | | |
| 16 Gauss | 16 | | | | | | | | | | |
| Response: | ACK (success) or NACK (error) | | | | | | | | | | |

| | | | | | | | | | | | |
|--------------------|---|--------------|-------------------|----------------|---|----------------|---|-----------------|----|-----------------|----|
| Identifier | 34 (0x22) | | | | | | | | | | |
| Name | GET_MAG_RANGE | | | | | | | | | | |
| Description | Get current magnetometer range. | | | | | | | | | | |
| Parameter | NONE | | | | | | | | | | |
| Response: | Int32 <table border="1"><tr><td>Range</td><td>Identifier</td></tr><tr><td>4 Gauss</td><td>4</td></tr><tr><td>8 Gauss</td><td>6</td></tr><tr><td>12 Gauss</td><td>12</td></tr><tr><td>16 Gauss</td><td>16</td></tr></table> | Range | Identifier | 4 Gauss | 4 | 8 Gauss | 6 | 12 Gauss | 12 | 16 Gauss | 16 |
| Range | Identifier | | | | | | | | | | |
| 4 Gauss | 4 | | | | | | | | | | |
| 8 Gauss | 6 | | | | | | | | | | |
| 12 Gauss | 12 | | | | | | | | | | |
| 16 Gauss | 16 | | | | | | | | | | |

Data Transmission Commands

| | |
|--------------------|--|
| Identifier | 9 (0x09) |
| Name | GET_SENSOR_DATA |
| Description | Retrieves the latest set of sensor data. A data packet will be composed as defined by SET_TRANSMIT_DATA. The currently set format can be retrieved with the sensor configuration word. |
| Parameter | NONE |
| Response: | See the LPBUS protocol explanation for a description of the measurement data format. |



| Identifier | 10 (0x0A) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|---|------------|-----------------------------------|-------|---|----|--|----|---|----|-------------------------------------|----|----------------------------|----|---|----|---|----|---------------------------------|----|---------------------------------------|----|---------------------------------------|----|---|----|---|----|------------------------------------|----|---------------------------------|----|---|----|-----------------------------------|----|------------------------------------|-------|---|
| Name | SET_TRANSMIT_DATA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Description | Set the current transmit data | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Parameter | Int32 <table border="1"><thead><tr><th>Bit</th><th>Reported State / Parameter</th></tr></thead><tbody><tr><td>0 - 9</td><td>0</td></tr><tr><td>10</td><td>Magnetometer data transmission enabled</td></tr><tr><td>11</td><td>Accelerometer data transmission enabled</td></tr><tr><td>12</td><td>Gyroscope data transmission enabled</td></tr><tr><td>13</td><td>Temperature output enabled</td></tr><tr><td>14</td><td>0</td></tr><tr><td>15</td><td>0</td></tr><tr><td>16</td><td>Angular velocity output enabled</td></tr><tr><td>17</td><td>Euler angle data transmission enabled</td></tr><tr><td>18</td><td>Quaternion orientation output enabled</td></tr><tr><td>19</td><td>0</td></tr><tr><td>20</td><td>0</td></tr><tr><td>21</td><td>Linear acceleration output enabled</td></tr><tr><td>22</td><td>16-bit data output mode enabled</td></tr><tr><td>23</td><td>0</td></tr><tr><td>24</td><td>Magnetometer compensation enabled</td></tr><tr><td>25</td><td>Accelerometer compensation enabled</td></tr><tr><td>26-31</td><td>0</td></tr></tbody></table> | Bit | Reported State / Parameter | 0 - 9 | 0 | 10 | Magnetometer data transmission enabled | 11 | Accelerometer data transmission enabled | 12 | Gyroscope data transmission enabled | 13 | Temperature output enabled | 14 | 0 | 15 | 0 | 16 | Angular velocity output enabled | 17 | Euler angle data transmission enabled | 18 | Quaternion orientation output enabled | 19 | 0 | 20 | 0 | 21 | Linear acceleration output enabled | 22 | 16-bit data output mode enabled | 23 | 0 | 24 | Magnetometer compensation enabled | 25 | Accelerometer compensation enabled | 26-31 | 0 |
| Bit | Reported State / Parameter | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 - 9 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | Magnetometer data transmission enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | Accelerometer data transmission enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Gyroscope data transmission enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | Temperature output enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | Angular velocity output enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | Euler angle data transmission enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | Quaternion orientation output enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | Linear acceleration output enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | 16-bit data output mode enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | Magnetometer compensation enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | Accelerometer compensation enabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 26-31 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Response: | ACK (success) or NACK (error) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Identifier | 11 (0x0B) | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|---|---|-------------------|---|---|---|-----|----|----|-----|----|----|-----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Name | SET_STREAM_FREQ | | | | | | | | | | | | | | | | | | | | | | | | |
| Description | Set the current streaming frequency | | | | | | | | | | | | | | | | | | | | | | | | |
| Parameter | Int32 <table border="1"><thead><tr><th>Frequency (Hz)</th><th>Identifier</th><th>Bit : 0~2 (GET_CONFIG return data)</th></tr></thead><tbody><tr><td>5</td><td>5</td><td>000</td></tr><tr><td>10</td><td>10</td><td>001</td></tr><tr><td>25</td><td>25</td><td>010</td></tr><tr><td>50</td><td>50</td><td>011</td></tr><tr><td>100</td><td>100</td><td>100</td></tr><tr><td>200</td><td>200</td><td>101</td></tr><tr><td>400</td><td>400</td><td>110</td></tr></tbody></table> | Frequency (Hz) | Identifier | Bit : 0~2 (GET_CONFIG return data) | 5 | 5 | 000 | 10 | 10 | 001 | 25 | 25 | 010 | 50 | 50 | 011 | 100 | 100 | 100 | 200 | 200 | 101 | 400 | 400 | 110 |
| Frequency (Hz) | Identifier | Bit : 0~2 (GET_CONFIG return data) | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 5 | 000 | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | 10 | 001 | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | 25 | 010 | | | | | | | | | | | | | | | | | | | | | | | |
| 50 | 50 | 011 | | | | | | | | | | | | | | | | | | | | | | | |
| 100 | 100 | 100 | | | | | | | | | | | | | | | | | | | | | | | |
| 200 | 200 | 101 | | | | | | | | | | | | | | | | | | | | | | | |
| 400 | 400 | 110 | | | | | | | | | | | | | | | | | | | | | | | |
| Response: | ACK (success) or NACK (error) | | | | | | | | | | | | | | | | | | | | | | | | |



| | |
|--------------------|--|
| Identifier | 66 (0x42) |
| Name | SET_TIMESTAMP |
| Description | Set the current sensor timestamp counter. Counter updates at 400Hz, i.e. setting timestamp counter equates to setting the timestamp to 1s. |
| Parameter | Int32 |
| Response: | ACK (success) or NACK (error) |

| | | | | | | | | | | | | | | | | | | | |
|--------------------|--|------------------|-------------------|-------|---|-------|---|-------|---|--------|---|--------|---|--------|---|--------|---|--------|---|
| Identifier | 84 (0x54) | | | | | | | | | | | | | | | | | | |
| Name | SET_UART_BAUDRATE | | | | | | | | | | | | | | | | | | |
| Description | Set the current UART baudrate | | | | | | | | | | | | | | | | | | |
| Parameter | Int32 <table border="1"><tr><td>Baud rate</td><td>Identifier</td></tr><tr><td>19200</td><td>0</td></tr><tr><td>38400</td><td>1</td></tr><tr><td>57600</td><td>2</td></tr><tr><td>115200</td><td>3</td></tr><tr><td>230400</td><td>4</td></tr><tr><td>256000</td><td>5</td></tr><tr><td>460800</td><td>6</td></tr><tr><td>921600</td><td>7</td></tr></table> | Baud rate | Identifier | 19200 | 0 | 38400 | 1 | 57600 | 2 | 115200 | 3 | 230400 | 4 | 256000 | 5 | 460800 | 6 | 921600 | 7 |
| Baud rate | Identifier | | | | | | | | | | | | | | | | | | |
| 19200 | 0 | | | | | | | | | | | | | | | | | | |
| 38400 | 1 | | | | | | | | | | | | | | | | | | |
| 57600 | 2 | | | | | | | | | | | | | | | | | | |
| 115200 | 3 | | | | | | | | | | | | | | | | | | |
| 230400 | 4 | | | | | | | | | | | | | | | | | | |
| 256000 | 5 | | | | | | | | | | | | | | | | | | |
| 460800 | 6 | | | | | | | | | | | | | | | | | | |
| 921600 | 7 | | | | | | | | | | | | | | | | | | |
| Response: | ACK (success) or NACK (error) | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | |
|--------------------|--|------------------|-------------------|-------|---|-------|---|-------|---|--------|---|--------|---|--------|---|--------|---|--------|---|
| Identifier | 85 (0x55) | | | | | | | | | | | | | | | | | | |
| Name | GET_UART_BAUDRATE | | | | | | | | | | | | | | | | | | |
| Description | Get the current UART baudrate | | | | | | | | | | | | | | | | | | |
| Parameter | NONE | | | | | | | | | | | | | | | | | | |
| Response: | Int32 <table border="1"><tr><td>Baud rate</td><td>Identifier</td></tr><tr><td>19200</td><td>0</td></tr><tr><td>38400</td><td>1</td></tr><tr><td>57600</td><td>2</td></tr><tr><td>115200</td><td>3</td></tr><tr><td>230400</td><td>4</td></tr><tr><td>256000</td><td>5</td></tr><tr><td>460800</td><td>6</td></tr><tr><td>921600</td><td>7</td></tr></table> | Baud rate | Identifier | 19200 | 0 | 38400 | 1 | 57600 | 2 | 115200 | 3 | 230400 | 4 | 256000 | 5 | 460800 | 6 | 921600 | 7 |
| Baud rate | Identifier | | | | | | | | | | | | | | | | | | |
| 19200 | 0 | | | | | | | | | | | | | | | | | | |
| 38400 | 1 | | | | | | | | | | | | | | | | | | |
| 57600 | 2 | | | | | | | | | | | | | | | | | | |
| 115200 | 3 | | | | | | | | | | | | | | | | | | |
| 230400 | 4 | | | | | | | | | | | | | | | | | | |
| 256000 | 5 | | | | | | | | | | | | | | | | | | |
| 460800 | 6 | | | | | | | | | | | | | | | | | | |
| 921600 | 7 | | | | | | | | | | | | | | | | | | |



Register Value Save and Reset Command

| | |
|--------------------|---|
| Identifier | 15 (0x0F) |
| Name | WRITE_REGISTERS |
| Description | Write the currently set parameters to flash memory. |
| Parameter | NONE |
| Response: | ACK (success) or NACK (error) |

| | |
|--------------------|---|
| Identifier | 16 (0x10) |
| Name | RESTORE_FACTORY_DEFAULTS |
| Description | Reset the LPMS parameters to factory default values. Please note that upon issuing this command your currently set parameters will be erased. |
| Parameter | NONE |
| Response: | ACK (success) or NACK (error) |

Reference Setting and Offset Reset Command

| | | | | | | | |
|--------------------|--|-------------|--------------|--------------|---|---------------|---|
| Identifier | 18 (0x12) | | | | | | |
| Name | SET_OFFSET | | | | | | |
| Description | Sets the orientation offset using one of the three offset methods. | | | | | | |
| Parameter | Int32 <table border="1"><tr><td>Mode</td><td>Value</td></tr><tr><td>Object reset</td><td>0</td></tr><tr><td>Heading reset</td><td>1</td></tr></table> | Mode | Value | Object reset | 0 | Heading reset | 1 |
| Mode | Value | | | | | | |
| Object reset | 0 | | | | | | |
| Heading reset | 1 | | | | | | |
| Response: | ACK (success) or NACK (error) | | | | | | |

| | |
|--------------------|---|
| Identifier | 82 (0x52) |
| Name | RESET_ORIENTATION_OFFSET |
| Description | Reset the orientation offset to 0 (unity quaternion). |
| Parameter | NONE |
| Response: | ACK (success) or NACK (error) |



Filter Settings Command

| Identifier | 41 (0x29) | | | | | | | | | | | | | |
|--|---|--|------|-------|----------------|---|---|---|--|---|--|---|---|---|
| Name | SET_FILTER_MODE | | | | | | | | | | | | | |
| Description | Set the sensor filter mode | | | | | | | | | | | | | |
| Parameter | Int32 <table border="1"><thead><tr><th>Mode</th><th>Value</th></tr></thead><tbody><tr><td>Gyroscope only</td><td>0</td></tr><tr><td>Accelerometer + gyroscope (Kalman filter)</td><td>1</td></tr><tr><td>Accelerometer+ gyroscope+ magnetometer (Kalman filter)</td><td>2</td></tr><tr><td>Accelerometer + gyroscope (DCM filter)</td><td>3</td></tr><tr><td>Accelerometer + gyroscope + Magnetometer (DCM filter)</td><td>4</td></tr></tbody></table> | | Mode | Value | Gyroscope only | 0 | Accelerometer + gyroscope (Kalman filter) | 1 | Accelerometer+ gyroscope+ magnetometer (Kalman filter) | 2 | Accelerometer + gyroscope (DCM filter) | 3 | Accelerometer + gyroscope + Magnetometer (DCM filter) | 4 |
| Mode | Value | | | | | | | | | | | | | |
| Gyroscope only | 0 | | | | | | | | | | | | | |
| Accelerometer + gyroscope (Kalman filter) | 1 | | | | | | | | | | | | | |
| Accelerometer+ gyroscope+ magnetometer (Kalman filter) | 2 | | | | | | | | | | | | | |
| Accelerometer + gyroscope (DCM filter) | 3 | | | | | | | | | | | | | |
| Accelerometer + gyroscope + Magnetometer (DCM filter) | 4 | | | | | | | | | | | | | |
| Response: | ACK (success) or NACK (error) | | | | | | | | | | | | | |

| Identifier | 42 (0x2A) | | | | | | | | | | | | | |
|--|---|--|------|-------|----------------|---|---|---|--|---|--|---|---|---|
| Name | GET_FILTER_MODE | | | | | | | | | | | | | |
| Description | Get the sensor filter mode | | | | | | | | | | | | | |
| Parameter | NONE | | | | | | | | | | | | | |
| Response: | Int32 <table border="1"><thead><tr><th>Mode</th><th>Value</th></tr></thead><tbody><tr><td>Gyroscope only</td><td>0</td></tr><tr><td>Accelerometer + gyroscope (Kalman filter)</td><td>1</td></tr><tr><td>Accelerometer+ gyroscope+ magnetometer (Kalman filter)</td><td>2</td></tr><tr><td>Accelerometer + gyroscope (DCM filter)</td><td>3</td></tr><tr><td>Accelerometer + gyroscope + Magnetometer (DCM filter)</td><td>4</td></tr></tbody></table> | | Mode | Value | Gyroscope only | 0 | Accelerometer + gyroscope (Kalman filter) | 1 | Accelerometer+ gyroscope+ magnetometer (Kalman filter) | 2 | Accelerometer + gyroscope (DCM filter) | 3 | Accelerometer + gyroscope + Magnetometer (DCM filter) | 4 |
| Mode | Value | | | | | | | | | | | | | |
| Gyroscope only | 0 | | | | | | | | | | | | | |
| Accelerometer + gyroscope (Kalman filter) | 1 | | | | | | | | | | | | | |
| Accelerometer+ gyroscope+ magnetometer (Kalman filter) | 2 | | | | | | | | | | | | | |
| Accelerometer + gyroscope (DCM filter) | 3 | | | | | | | | | | | | | |
| Accelerometer + gyroscope + Magnetometer (DCM filter) | 4 | | | | | | | | | | | | | |

| Identifier | 43 (0x2B) | | | | | | | | | | | |
|---------------------|---|--|---------------------|-------|------|---|--------|---|--------|---|---------|---|
| Name | SET_FILTER_PRESET | | | | | | | | | | | |
| Description | Set one of the filter parameter presets for accelerometer and magnetometer covariance strength | | | | | | | | | | | |
| Parameter | Int32 <table border="1"><thead><tr><th>Correction strength</th><th>Value</th></tr></thead><tbody><tr><td>Weak</td><td>0</td></tr><tr><td>Medium</td><td>1</td></tr><tr><td>Strong</td><td>2</td></tr><tr><td>Dynamic</td><td>3</td></tr></tbody></table> | | Correction strength | Value | Weak | 0 | Medium | 1 | Strong | 2 | Dynamic | 3 |
| Correction strength | Value | | | | | | | | | | | |
| Weak | 0 | | | | | | | | | | | |
| Medium | 1 | | | | | | | | | | | |
| Strong | 2 | | | | | | | | | | | |
| Dynamic | 3 | | | | | | | | | | | |
| Response: | ACK (success) or NACK (error) | | | | | | | | | | | |



| Identifier | 44 (0x2C) | | | | | | | | | | |
|---------------------|---|---------------------|-------|---------|---|--------|---|--------|---|------|---|
| Name | GET_FILTER_PRESET | | | | | | | | | | |
| Description | Get current filter preset | | | | | | | | | | |
| Parameter | NONE | | | | | | | | | | |
| Response: | Int32 <table border="1"><thead><tr><th>Correction strength</th><th>Value</th></tr></thead><tbody><tr><td>Dynamic</td><td>0</td></tr><tr><td>Strong</td><td>1</td></tr><tr><td>Medium</td><td>2</td></tr><tr><td>Weak</td><td>3</td></tr></tbody></table> | Correction strength | Value | Dynamic | 0 | Strong | 1 | Medium | 2 | Weak | 3 |
| Correction strength | Value | | | | | | | | | | |
| Dynamic | 0 | | | | | | | | | | |
| Strong | 1 | | | | | | | | | | |
| Medium | 2 | | | | | | | | | | |
| Weak | 3 | | | | | | | | | | |

Device Info

| | |
|--------------------|--|
| Identifier | 90 (0x5A) |
| Name | GET_SERIAL_NUMBER |
| Description | Get sensor serial number |
| Parameter | NONE |
| Response: | Char[24] Character array of length 24 |

| | |
|--------------------|-------------------------------------|
| Identifier | 92 (0x5C) |
| Name | GET_FIRMWARE_INFO |
| Description | Get firmware info |
| Parameter | NONE |
| Response: | Char[16] Firmware name - version |

