Monitorización de movimiento

Sensor de análisis de orientación para el sector naval

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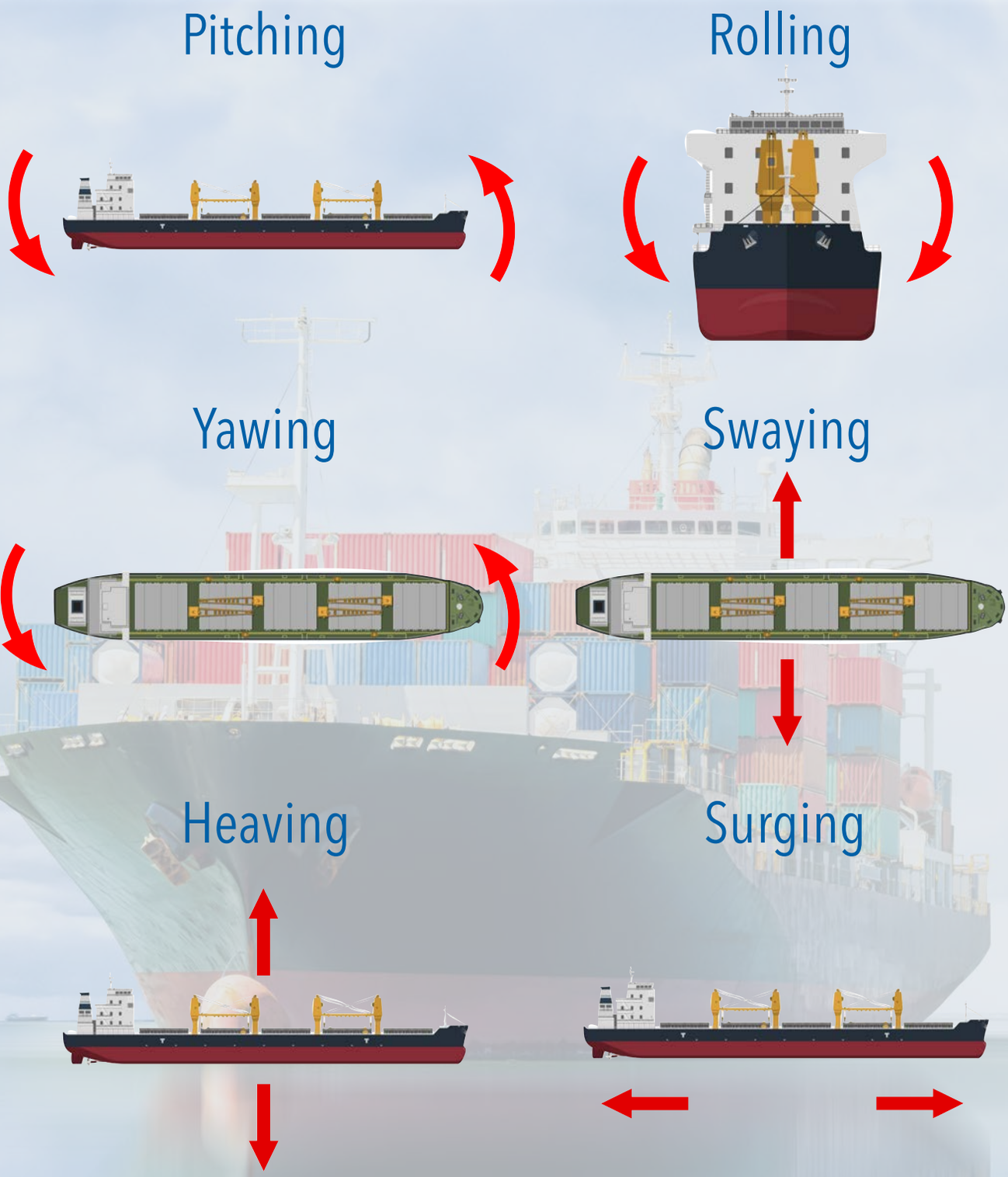
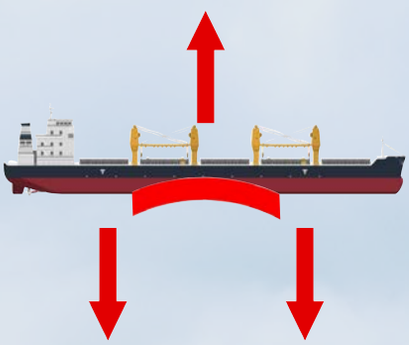
sensors controls

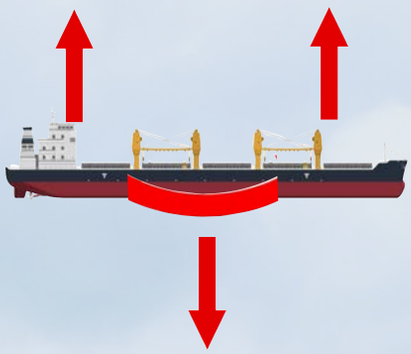
Sensor de análisis de movimiento KPM100



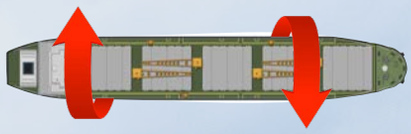
Hogging



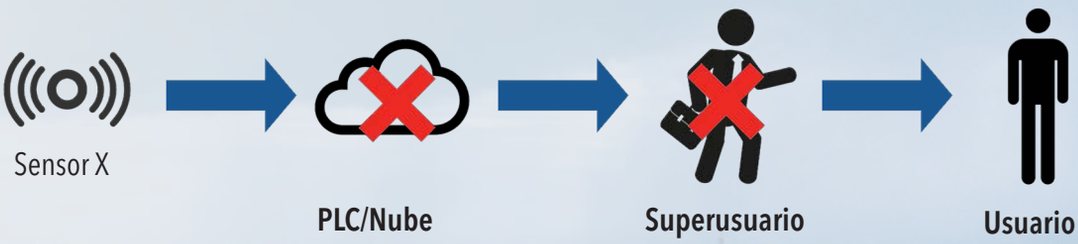
Sagging

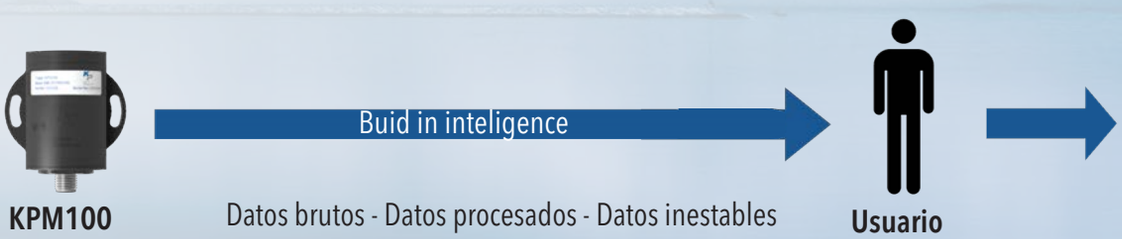


Twisting



Simplificamos la recogida de datos





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Aplicaciones para el análisis de movimiento

Los operadores de buques tienen el reto de garantizar el máximo rendimiento. Los datos recogidos durante el funcionamiento del buque proporcionan al operador los conocimientos necesarios para planificar y ejecutar el mantenimiento con la máxima eficacia.

Nuestro sensor KPM100 analiza el movimiento. Al utilizarlo, se proporcionan datos en directo sobre el estado del buque. El KPM100 recoge datos sobre todos los movimientos del barco, ya sea la velocidad, la aceleración, la dirección y los ángulos de movimiento en pitch, roll y yaw. Se pueden establecer alarmas para evitar situaciones en las que el rendimiento del buque se vea comprometido, o para indicar cuándo es necesario reducir la velocidad para garantizar la seguridad. Los datos combinados de varios KMP100 pueden utilizarse para calcular sagging, hogging, y twisting del buque.

Además, los datos pueden utilizarse para mantener el barco estable durante la carga, en navegación e incluso para controlar el sistema de agua de lastre.

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Kjærulf Pedersen a/s

Inclinometer type: KPM 100

Sheet no.

Application:

- Orientation measurements

Properties:

- Roll output of ±180°
- Pitch output of ±90°
- Yaw output of ±180°
- Accelerations in three directions
- Angular velocity in three directions
- Magnetic felt strength in three directions
- Modbus communication
- Alarms
- Bootloader

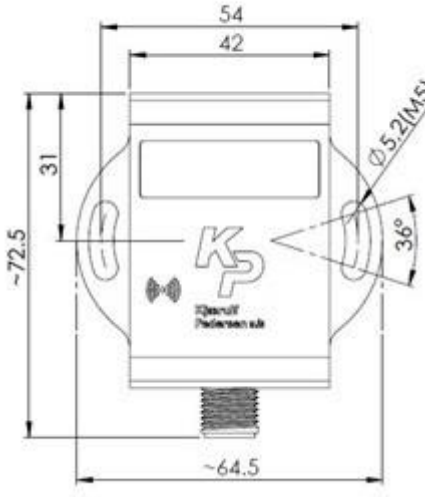
	7700001	7700-E010817V1

ELECTRICAL SPECIFICATIONS:

Supply:
10-28 VDC.

Output:
Modbus RTU RS485 protocol.

Connection: M12
Others on request depending on quantity



FUNCTIONALITY.

The sensor is built for measuring orientation.
The main components of the sensor are an accelerometer, a gyroscope, a magnetometer, and a DSP processor for inclinometer calculations.
Data output is the orientation in degrees.

ENVIRONMENTAL:

Temperatures:
Temperature on electronics: -40°C to 80°C.

EMC:
Emission: Domestic, EN 61000-6-3
Immunity: Industrial, EN 61000-6-2

Kjaerulf Pedersen a/s, Taastrupgaardsvej 8-10, DK-2630 Taastrup, Tel.: +45 39760203, Fax: +45 39760501, sensor@kp-as.com, www.kp-as.com

User guide KPM100

This is the user guide for the KPM100. It contains all information needed to connect and use the sensor. It is assumed that the user is familiar with the Modbus protocol.

Any questions not answered by this document can be forwarded to abs@kp-as.com.

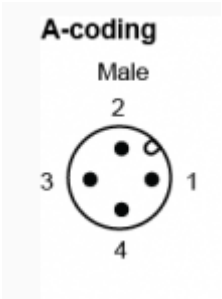
Contents

Sensor parameters

Parameters	Value
Supply voltage	10-28Vdc
Temperature range: Operational Storage	 -40-80°C. -50-80°C.
Output: Roll Pitch Yaw Angular velocity Acceleration Magnetic field strength	 ±180° ±90° ±180° [Deg/s] [g] [Gauss]
Features: Alarms Bootloader	
Communication: Connection Protocol	 Male M12 Modbus RTU RS485

Connection

Communication with the KPM100 is done through an A-coded M12 connection.



M12 connector pin-out:

- Pin 1: Operating voltage
- Pin 2: RS485A
- Pin 3: 0V
- Pin 4: RS485B

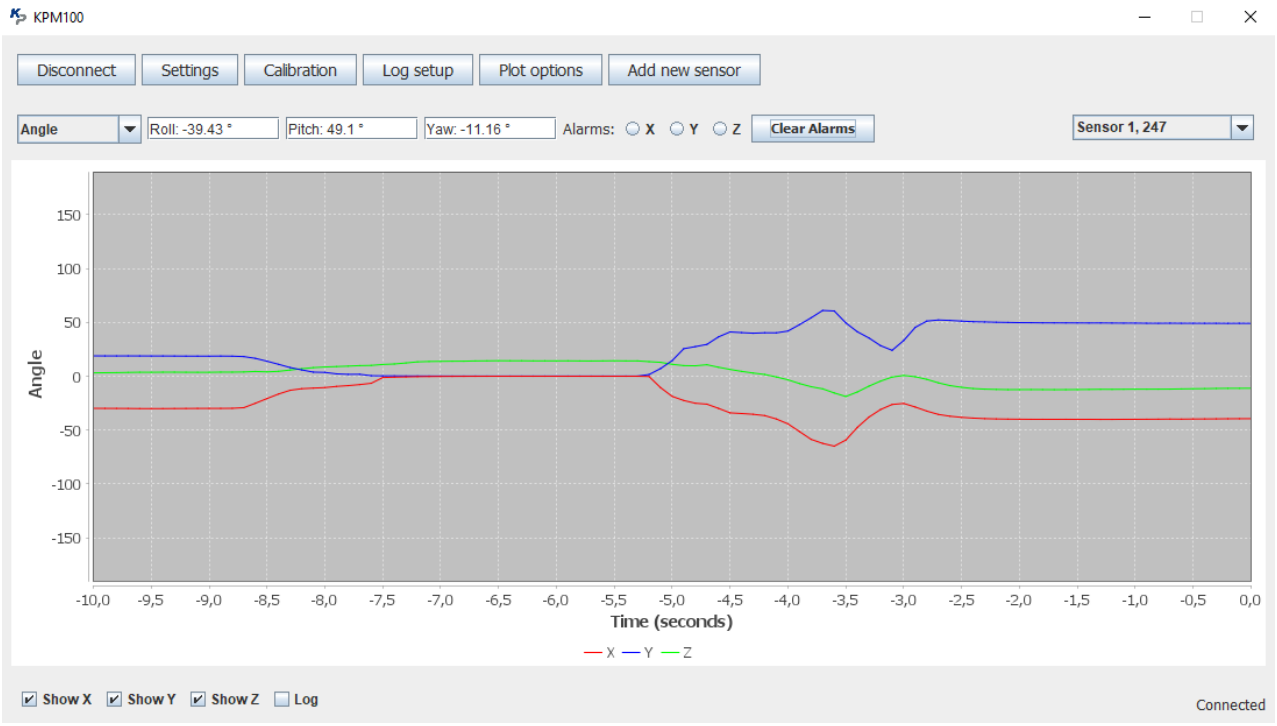
Placement

The KPM100's default axis-layout can be seen on the figure below. This axis-layout can be changed depending on the desired reference (see section "Z-axis"). If mounted vertically on a wall or other vertical surfaces it is recommended to use a Z-axis value of 4. Avoid choosing an axis-layout such that the pitch value exceeds the pitch limits.

KPM100 GUI

To simplify the setup of the KPM100 the KPM100 GUI is recommended. The GUI has the following features:

- Display sensor output graphically.
- Easy settings and alarms setup.
- Logging features
- Greatly simplifies the magnetometer calibration process.



Magnetometer calibration

To get a valid yaw output it is necessary to calibrate the internal magnetometer. It is highly recommended to use the KPM100 GUI to perform this calibration. When using the GUI do the following:

1. Start up the GUI and connect to the relevant sensor.
2. Open the calibration window.
3. Press the “calibrate magnetometer”-button.
4. Press the “sample”-button. This stores the first sample.
5. Turn the sensor such that its roll and pitch is significantly different from previous samples. The actual roll and pitch values are irrelevant, they just need to be different from other samples.
6. Press the “sample”-button.
7. Repeat steps 5 and 6 until approximately 8 samples have been taken.
8. Press the “calculate”-button.
9. In the bottom panel press the “upload”-button.

When calibrating without the KPM100 GUI refer to the external link below:
https://www.nxp.com/docs/en/application-note/AN4246.pdf

Bootloader

The KPM100 is equipped with an EZBL- bootloader that allows the firmware, in the sensor, to be updated via the Modbus communication cables.

The firmware is encoded in the bl2 file type. The master must upload a valid bl2 firmware file according to the standard EZBL framework hand-shake definition from Microchip.

When the KPM100 starts up it is in bootloader-mode for 2 seconds. In this mode it looks for a bl2 formatted file containing the new firmware update. The bootloader recognizes a bl2 file by the file’s unique hash code. If the hash is detected within the 2 seconds, the sensor remains in the bootloader until a valid file has been received. If no hash is detected within the 2 seconds, and a valid application exists, the application is started.

If an ongoing bl2-file upload is aborted the bootloader will remain active, but the old application in the sensor is deleted. A restart will in this cause the sensor to start and remain in bootloader-mode, until new valid firmware is successfully uploaded.

New firmware can also be uploaded by the KP-flasher, a java program created to simplify the uploading process. Contact abs@kp-as.com for more information about the KP-flasher.

Modbus interface

The communication protocol is a Modbus RTU RS485 protocol. Only three commands are accepted:

- FC3 – Read the holding registers
- FC4 – Read the input registers
- FC16 – Write multiple holding registers

Modbus holding registers

These registers are used to change the KPM100's settings. The Modbus address of each setting can be seen in the table below.

Alias	Address	Default value
Modbus address	0x00	247
Baud rate	0x01	1152
Parity	0x02	0
Calibrate gyroscope	0x03	0
Calibrate accelerometer	0x04	0
Z-axis	0x05	3
G-range	0x06	2
Degrees Per Second (DPS)	0x07	500
Magnetometer-range	0x08	4
Clear Alarm	0x0B	0
Restart	0x0C	0
Magnetometer calibration X	0x0D-0x0E	0
Magnetometer calibration Y	0x0F-0x10	0
Magnetometer calibration Z	0x11-0x12	0
Roll alarm low limit	0x14	-90
Roll alarm high limit	0x15	90
Pitch alarm low limit	0x16	-90
Pitch alarm high limit	0x17	90
Yaw alarm low limit	0x18	-90
Yaw alarm high limit	0x19	90

Modbus address

This is the Modbus address of the KPM100. Any value between 1 – 247 can be chosen.

Baud rate

This address controls the baud rate. Four different values can be chosen:

- 96: 9600 baud
- 192: 19200 baud
- 576: 57600 baud
- 1152: 115200 baud (default)

Parity rate

This address controls the parity bit. Three different values can be chosen

- 0: Even parity (default)
- 1: Odd parity
- 2: None parity

Calibrate gyroscope

This register controls the gyroscope calibration. It is important that the sensor is not moved during the calibration. The calibration last for approximately 5 seconds.

- When writing 1 to this register, the calibration routine for the gyroscope is started.
- When writing 0 to this register the gyroscope calibration values are deleted.

Calibrate accelerometer

This register controls the accelerometer calibration. When calibrating it is important that the sensor is places such that only the z-axis (see section “Z-axis” below) is affected by gravity. The sensor should not be moved during the calibration. The calibration last for approximately 5 seconds.

- When writing 1 to this register, the calibration routine for the accelerometer is started.
- When writing 0 to this register the accelerometer calibration values are deleted.

Z-axis

This register controls what direction the z-axis has. To get the maximum performance the z-axis should be chosen such that it points opposite of gravity most of the time. For example, if the sensor is mounted on a horizontal surface choose Z-axis = 3. If mounted on a wall or other vertical objects choose Z-axis = 2, 3 or 4 depending on the mounting rotation.

Z-axis = 3
(default)

Z-axis = 2

Z-axis = 1

Z-axis = 4

G-range

This register controls the g-range of the accelerometer. It can take 4 different values:

- 2: ± 2 g (default)
- 4: ± 4 g
- 8: ± 8 g
- 16: ± 16 g

Note! Changing this value deletes the accelerometer calibration values.

Degrees Per Second

This register controls the Degrees Per Second range (DPS) of the gyroscope. It can take 3 different values:

- 245: ± 245 °/s
- 500: ± 500 °/s (default)
- 2000: ± 2000 °/s

Note! Changing this value deletes the gyroscope calibration values.

Magnetometer range

This register controls the magnetometer range. It can take 4 different values:

- 4 ± 4 Gauss (default)
- 8: ± 8 Gauss
- 12: ± 12 Gauss
- 16: ± 16 Gauss

Note! Changing this value deletes the magnetometer calibration values.

Alarm low limit

These registers control the lower alarm limit. When either a roll, pitch or yaw measurement is below these limits an alarm is raised (se section “Alarms”). The addresses are:

- 0x14: Roll low alarm limit.
- 0x16: Pitch low alarm limit.
- 0x18: Yaw low alarm limit.

Note that the pitch’s range is ± 90 so any pitch alarm outside this range will never be triggered.

Alarm high limit

These registers control the higher alarm limit. When either a roll, pitch or yaw measurement is above these limits an alarm is raised (se section “Alarms”). The addresses are:

- 0x15: Roll high alarm limit.
- 0x17: Pitch high alarm limit.
- 0x19: Yaw high alarm limit.

Note that the pitch’s range is ± 90 so any pitch alarm outside this range will never be triggered.

Clear Alarm

When writing 1 to this register the clears the alarms (se section “Alarms”). No other values are accepted.

Restart

Writing 1 to this register restarts the sensor. No other values are accepted.

Magnetometer calibration values

The addresses from 0x0D to 0x12 contains the magnetometer calibration values. They are stored as floats in the following format:

b1	b0	b3	b2

Where b0 is the least significant byte.

It is recommended that the KPM100 GUI is used to calibrate.

Modbus input registers

The input registers contain the inclinometer data and are read-only registers. Each address can be seen below.

Alias	**Address**
Roll	0x00
Pitch	0x01
Yaw	0x02
Roll 360	0x03
Pitch 360	0x04
Yaw 360	0x05
Roll percentage	0x06

Pitch percentage	0x07
Yaw percentage	0x08
Accelerometer X	0x09
Accelerometer Y	0x0A
Accelerometer Z	0x0B
Angular velocity X	0x0C
Angular velocity Y	0x0D
Angular velocity Z	0x0E
Magnetic field strength X	0x0F
Magnetic field strength Y	0x10
Magnetic field strength Z	0x11
Roll alarm	0x12
Pitch alarm	0x13
Yaw alarm	0x14

Roll, pitch and yaw

These registers contain the orientation. These are calculated by mixing the accelerometer and gyroscope measurements. The registers are:

- 0x00: Roll ($\pm$180°)
- 0x01: Pitch ($\pm$90°)
- 0x02: Yaw ($\pm$180°)

Note, these values are multiplied by 100.

Roll, pitch and yaw 360

These registers contain the same information as the roll, pitch and yaw registers. However, here the values are between 0° to 360°. The registers are:

- 0x03: Roll (0° to 360°)
- 0x04: Pitch (0° to 90° and 270° to 360°)
- 0x05: Yaw (0° to 360°)

Roll, pitch and yaw percentage

These registers contain the same information as the roll, pitch and yaw registers. However, they are converted to percentage of 90 degrees.

Accelerations

These registers contain the data measured by the accelerometer. The addresses are:

- 0x09: The x-axis
- 0x0A: The y-axis
- 0x0B: The z-axis

The accelerations are measured in g. Note that the values are scaled by 100.

Angular velocity

These registers contain the angular velocity measured by the gyroscope. The addresses are

- 0x0C: Angular velocity around the x-axis

- 0x0D: Angular velocity around the y-axis
- 0x0E: Angular velocity around the z-axis

The angular velocities are measured in °/s. Note that the values are scaled by 100.

Magnetic field strength

These registers contain the magnetic field strength measured by the magnetometer. The addresses are

- 0x0F: Angular velocity around the x-axis
- 0x10: Angular velocity around the y-axis
- 0x11: Angular velocity around the z-axis

The magnetic field strengths are measured in gauss. Note that the values are scaled by 10.

Alarms

These registers contain the alarms. When the angels are out of the area defined by the alarm limits in the holding addresses 0x09 and 0x0A an alarm is raised. The alarms can be cleared by writing 1 to the “Clear alarm” register (holding address 0x0B). Note that the alarm is raised until cleared.

The addresses are

- 0x12: Roll alarm
- 0x13: Pitch alarm
- 0x14: Yaw alarm