BMI270 Legacy Features
Application Note

Application Note – Legacy Features

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1. Introduction

BMI270 is a low power IMU optimized for wearable applications. The IMU combines precise acceleration and angular rate measurement with intelligent on-chip motion-triggered interrupt features. The 6-axis sensor combines a 16-bit triaxial gyroscope and a 16-bit triaxial accelerometer in a compact 2.5 x 3.0 x 0.8 mm3 LGA package

BMI270 is a member of Bosch Sensortec's BMI260 family of IMUs, targeting fast and accurate inertial sensing in wearable applications. BMI270 features Bosch's automotive-proven gyroscope technology with an improved accelerometer. Significant improvements in BMI270 include, but are not restricted to, the overall accelerometer performance, i.e. an extremely low zero-*g* offset and sensitivity error, low temperature drifts, robustness over PCB strain and a low noise density.

BMI270 features the industry's first self-calibrating gyroscope using motionless CRT (Component Re-Trimming) functionality to compensate MEMS typical soldering drifts, ensuring post-soldering sensitivity errors down to ± 0.4%.

BMI270 includes intuitive gesture, context and activity recognition with an integrated plug-and-play step counter/detector, which is optimized for accurate step counting in wrist-worn devices. The IMU is also well suited for other types of wearable devices, such as hearables, smart clothes, smart shoes, smart glasses and ankle bands.

BMI270 is available in application-specific versions: gesture and context & activity. The 'gesture' version includes flick in/out, arm up/down, and wrist tilt features. The 'context and activity' version has advanced features for recognizing context activity and activity change, for example standing, walking and log car parking by detecting the activity change. In case none of the features are needed but FIFO size is critical, there is a Max FIFO configuration.

BMI270 'legacy' version includes low-power features available in the legacy IMU, BMI160 that is currently NRND. Note that BMI270 is p2p compatible with BMI160.

1.1. Legacy Features

This application note describes the configuration of BMI270 that offers all low-power features as in the legacy IMU, BMI160. This Application Note is targeted towards users transitioning from BMI160 (currently NRND) to BMI270 and require features/interrupts available in BMI160.

For complete details regarding BMI270 specifications (e.g. pin-out, power modes, self-test, temperature sensor, Sensor Time, FIFO), Digital interfaces (primary/secondary), landing pattern, HSMI and sensor API refer the following:

https://www.bosch-sensortec.com/products/motion-sensors/imus/bmi270.html

https://www.bosch-sensortec.com/media/boschsensortec/downloads/datasheets/bst-bmi270-ds000.pdf

https://github.com/BoschSensortec/BMI270-Sensor-API

2. Quick Start Guide

The purpose of this section is to help developers who want to start working with BMI270 by giving some basic hands-on application examples to get started.

2.1. Note about using BMI270

The communication between application processor and BMI270 will happen either over I2C or SPI interface.

Each register read operation includes dummy bytes:

- I2C: 0
- SPI: 1

For simplicity the dummy bytes are not shown in the examples below.

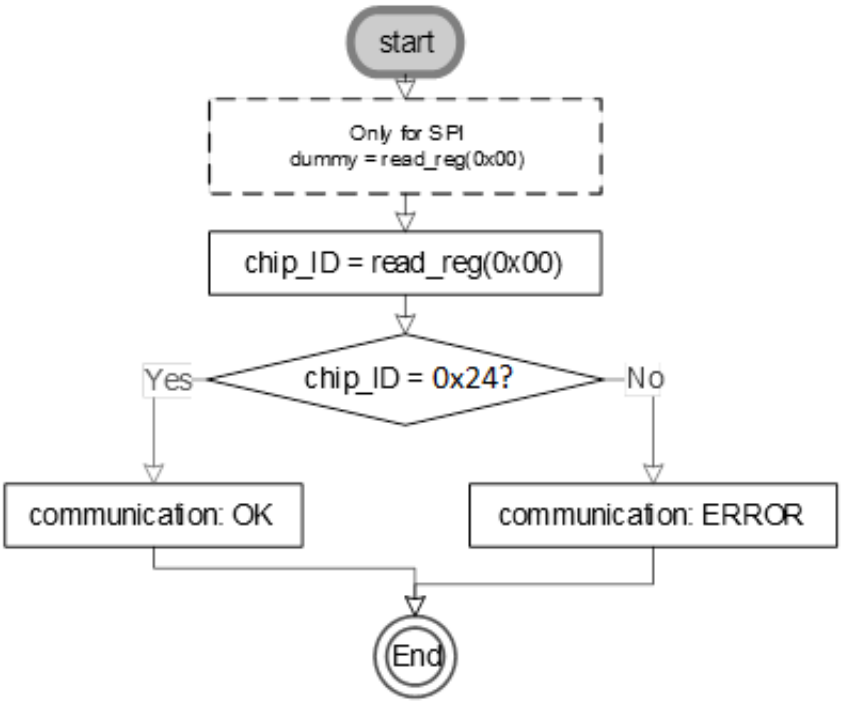
Before starting the test, BMI270 has to be properly connected to the master (AP) and powered up. The device is configured for advance power save mode after POR or soft reset. For details on the interface operation in advanced power save mode, see the description of Register PWR_CONF.adv_power_save For more information about the interfaces, see BMI270 data sheet

2.2. First application setup examples algorithms:

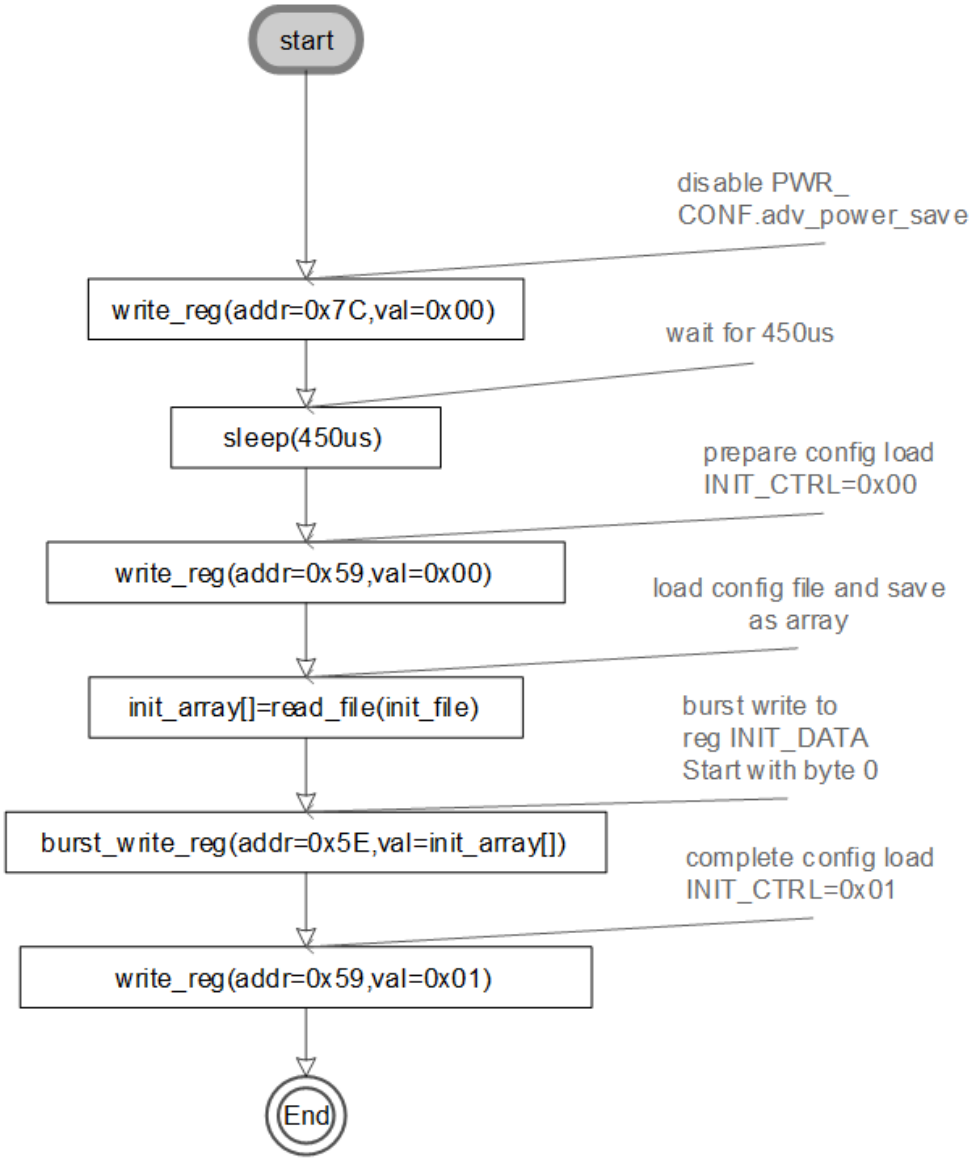
After correct power up by setting the correct voltage to the appropriate external pins, BMI270 enters automatically into the Power On Reset (POR) sequence. In order to properly use BMI270, certain steps from host processor front are needed. The most typical operations will be explained in the following application examples in form of flow diagrams.

1. *Testing communication and initializing BMI270*

a. Reading chip id CHIP_ID (0x24) (checking correct communication). The interface is coming up configured for I2C, the initial dummy read configures it to SPI.

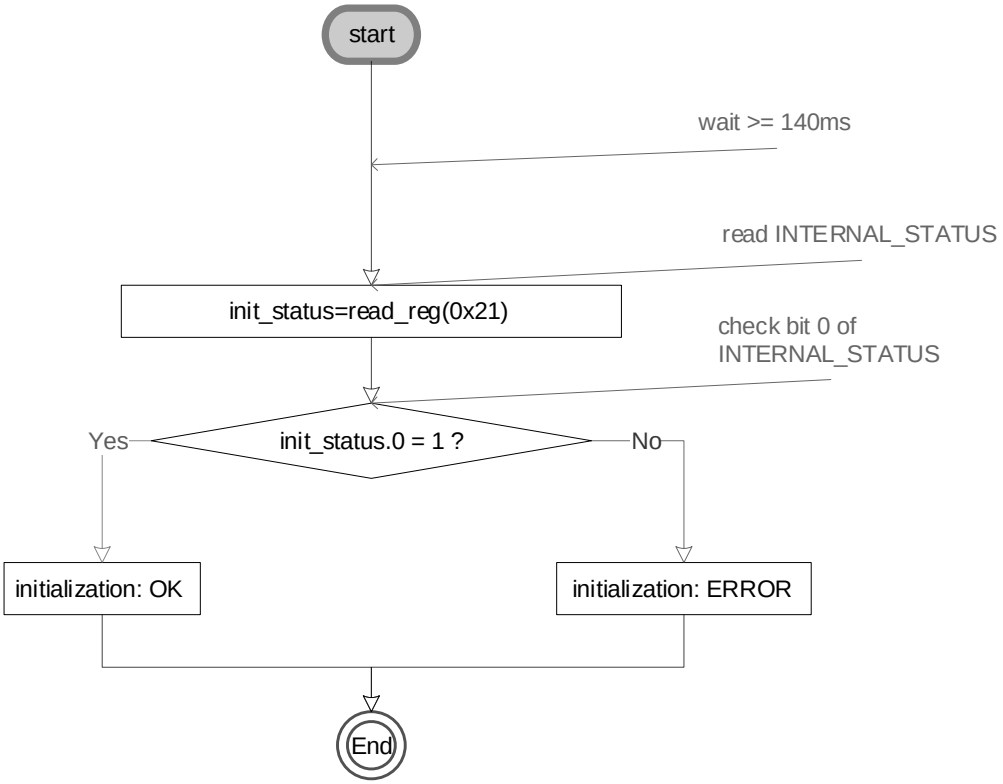


b. Performing initialization sequence[1]



[1] The bmi270_config_file in https://github.com/BoschSensortec/BMI270-Sensor-API/blob/master/bmi270_legacy.c

c. Checking the correct initialization status

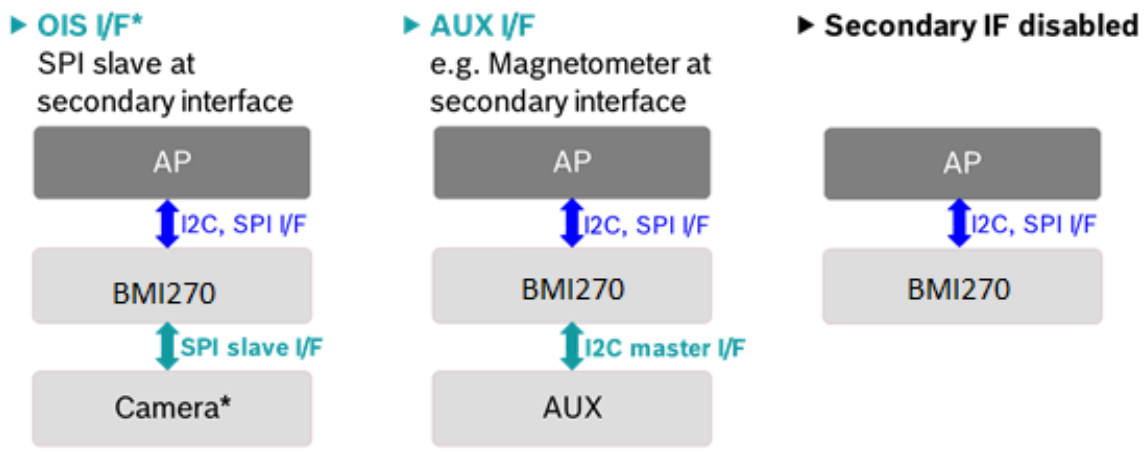


Note: To configure BMI270 in Low-power mode / Normal mode / Performance mode refer BMI270 data sheet

3. Functional Description

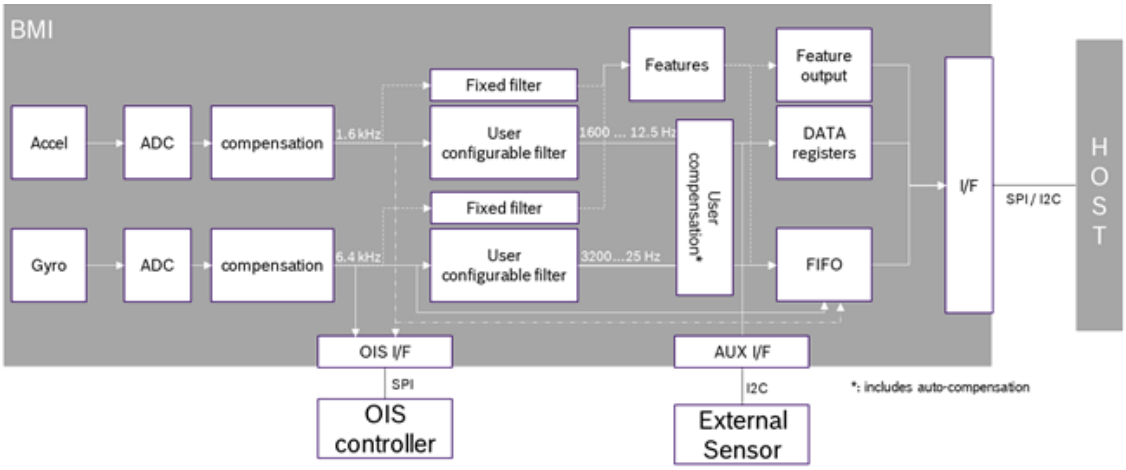
3.1. System Configurations

BMI270 has 14 external I/F pins and supports SPI and I2C protocols on its primary interface to the host system. BMI270 supports on its secondary interface (I2C master) an auxiliary sensor configuration (e.g. a magnetometer) configuration. Both configurations work independent of the configuration (SPI/I2C) of the primary interface. If the secondary I/F is configured as AUX I/F, the sensor data of the IMU and the AUX sensor are synchronized.



3.2. Block Diagram

BMI270



For details regarding Supply Voltage, see BMI270 data sheet

3.3. **Power-On-Reset (POR) and Device Initialization**

During POR the voltages VDD/VDDIO are ramped to their respective target values. After reaching the target supply voltages, all registers are accessible after a delay of 450 µs.

After every POR or soft reset, the IMU remains in suspend mode. To get ready for operation the device must be initialized through the following procedure:

- Disable advanced power save mode: PWR_CONF.adv_power_save =0b0
- Wait for 450 µs (or 12 LSB of SENSORTIME_0)
- Write INIT_CTRL.init_ctrl = 0x00 – to prepare config load
- Upload configuration file
    - Burst write 8 KB of initialization data to Register INIT_DATA (start with byte 0 of initialization data)
    - The configuration file is available on GitHub: https://github.com/BoschSensortec/BMI270-Sensor-API/blob/master/bmi270_legacy.c

      Optionally: Burst read configuration file from Register INIT_DATA and check correctness by comparing it to the data written to the register in the previous step.
- Write INIT_CTRL.init_ctrl = 0x01 – to complete config load.
  Note: This operation **must not** be performed more than once after POR or soft reset.
- Wait until Register INTERNAL_STATUS.message contains the value 0b0001. This will happen after at most 20 ms.

After the initialization sequence is completed, the power mode of the device is automatically set to “Configuration mode”. Now it is possible to switch to other power modes and the device is ready for operation as required and described in the following sections.

For details regarding switching to power modes, Sensor Data (Accel/Gyro and data processing in different modes) and possible filter settings, see BMI270 data sheet

3.4. **FIFO**

BMI270 supports the following FIFO operating modes:

- Streaming mode: overwrites oldest data on FIFO full condition
- FIFO mode: discards newest data on FIFO full condition

The FIFO size is 2 KB and supports the following interrupts:

- FIFO full interrupt
- FIFO watermark interrupt

FIFO is enabled for accelerometer data with FIFO_CONFIG_1.fifo_acc_en=0b1, for gyroscope data with FIFO_CONFIG_1.fifo_gyr_en=0b1, and auxiliary interface (e.g. magnetometer) data with FIFO_CONFIG_1.fifo_aux_en=0b1 (0b0=disabled).

The FIFO may be used in all power modes of BMI270. For further details on FIFO refer Chapter 4.7 of BMI270 data sheet

Bit	7	6	5	4	3	2	1	0
Content	fh_mode<1:0>		fh_parm<3:0>				reserved	

FIFO header contains information on fh_mode and fh_param as shown by bit-field definition.

3.5. General Interrupt Pin Configuration

Electrical Interrupt Pin Behavior

Both interrupt pins PIN1 and PIN2 can be configured to show the desired electrical behavior. Interrupt pins can be enabled in INT1_IO_CTRL.output_en and INT2_IO_CTRL.output_en. The characteristic of the output driver of the interrupt pins may be configured with bits INT1_IO_CTRL.od and INT2_IO_CTRL.od. By setting these bits to 0b1, the output driver shows open-drive characteristic, by setting the configuration bits to 0b0, the output driver shows push-pull characteristic.
The electrical behavior of the Interrupt pins, whenever an interrupt is triggered, can be configured as either “active-high” or “active-low” via INT1_IO_CTRL.lvl or INT2_IO_CTRL.lvl.

Both interrupt pins can be configured as input pins via INT1_IO_CTRL.input_en and INT2_IO_CTRL.input_en. This is necessary when FIFO tag feature is used (see Section FIFO synchronization with external interrupts” in BMI270 datasheet). If both are enabled, the input (e.g. marking FIFO) is driven by the interrupt output.

BMI270 supports edge and level triggered interrupt inputs, this can be configured through FIFO_CONFIG1.fifo_tag_int1_en and FIFO_CONFIG1.fifo_tag_int2_en.

BMI270 supports non-latched and latched interrupts modes for data ready, FIFO watermark, FIFO full, error, and the advanced feature interrupts. The mode is selected by INT_LATCH.int_latch. Non-latched interrupts are designed for systems using edge triggered interrupts, latched interrupts are designed for systems using level-triggered interrupts.

In latched mode an asserted interrupt status in INT_STATUS_0 (advanced feature interrupts) or INT_STATUS_1 (data ready, FIFO and error interrupts) and the selected pin are reset if the corresponding status register is read. If the interrupt activation condition still holds when the interrupt is reset, the interrupt status and pin are asserted again. If more than one interrupt pin is used in latched mode, all interrupts in INT_STATUS_0 should be mapped to one interrupt pin and all interrupts in INT_STATUS_1 should be mapped to the other interrupt pin. If just one interrupt pin is used all interrupts may be mapped to this interrupt pin.

In the non-latched mode the selected pin are reset as soon as the activation condition is not valid anymore. The interrupt status bits are active until read by the host.

Interrupt Pin Mapping

The data ready, FIFO watermark, FIFO full, error, and the advanced feature interrupts are mapped to the external INT1 or INT2 pins by setting the corresponding bits in the Registers INT_MAP_DATA, INT1_MAP_FEAT and INT2_MAP_FEAT. To unmap these interrupts, the corresponding bits must be reset.

Once an interrupt triggered the output pin, the host can derive the source of the interrupt of the corresponding status bit in the Register: INT_STATUS_0 and INT_STATUS_1.

3.6. **Advanced Features**

Global Configuration

The configuration of the interrupt feature engine is described in the Registers FEATURES. These registers are partitioned into several pages, the page valid for the next read or write to the Registers FEATURES is selected by the Register FEAT_PAGE.page. Writes to a FEATURES register must be 16-bit word oriented, i.e. writes should start at an even address (2m) and the last byte written should be at an odd address (2n+1), where 0x30<=2m<=2n<0x3F. If the write start address is less than 0x30 the write may start at any address (see example 4 below), if the end address is greater than 0x3F, it may stop at any address (see example 5 below).

- For register writes which stop at an even SPI address (2n), the data at the odd SPI address (2n+1) are undefined (see Example 2, 3 below)
- For writes which start at an odd SPI address (2m+1), the data at the even address (2m) are undefined. (see Example 3 below)

Ex. 1) Write 4 bytes starting at address 0x30

0x30	Valid Data
0x31	Valid Data
0x32	Valid Data
0x33	Valid Data

Ex. 2) Write 3 bytes starting at address 0x30

0x30	Valid Data
0x31	Valid Data
0x32	Valid Data
0x33	Undefined

Ex. 3) Write 2 bytes starting at address 0x31

0x30	Undefined
0x31	Valid Data
0x32	Valid Data
0x33	Undefined

Ex. 4) Write 9 bytes starting at address 0x29

0x29	Valid Data
0x2A	Valid Data
⋮	⋮
0x2E	Valid Data
0x2F	Valid Data
0x30	Valid Data
0x31	Valid Data

Ex. 5) Write 5 bytes starting at address 0x3E

0x3E	Valid Data
0x3F	Valid Data
0x40	Valid Data
0x41	Valid Data
0x42	Valid Data
⋮	⋮

Make sure the sensor is initialized properly before the feature configuration is performed (see description in section 3.3.)

Some features generate interrupts. INT1_MAP_FEAT and INT2_MAP_FEAT configure these features. INT_STATUS_0 reports the interrupt source.

In order to minimize the power consumption or to enable always-on motion sensing, all advanced features (algorithms) rely on accelerometer data samples.

Minimum Bandwidth Settings

If the filter performance of the accelerometer is configured to high performance (ACC_CONF.acc_filter_perf is 0b1), the features operate at highest performance independent of the ODR and the bandwidth set by the host.

If the filter performance of the accelerometer is configured to low power (ACC_CONF.acc_filter_perf is 0b0), the feature performance is depending on the ODR and the averaging factor (ACC_CONF.acc_bwp) set by the host:

1. Tap Detection, HighG detection the ODR must be set to minimum 200 Hz
2. The other Features, the ODR must be set to minimum 50 Hz

If the device configuration does not meet the minimum requirements, the corresponding flag in the Register INTERNAL_STATUS *is set, if one of the advanced features is enabled. In this case the features are still evaluated, the same number of samples are evaluated, but they are sampled at the lower rate.*

Error Interrupts

The device supports an error interrupt, which triggers if the device cannot be recovered without a soft reset or a POR. This error interrupt is enabled through INT_MAP_DATA. The interrupt status is available in INT_STATUS_1.err_int. After restarting a device reinitialization must be done.

Axis remapping for interrupt features

If the coordinate system of the end device differs from the sensor coordinate system, the sensor axis must be remapped to use the orientation dependent features (e.g. orientation interrupt, flat interrupt) properly.

Axis remapping register allows the host to freely map individual axis to the coordinate system of the used platform. Individual axis can be mapped to any other defined axis. The sign value of the axis can be also configured. For example x axis can be mapped to –x axis, +y axis, - y axis, +z axis or –z axis. Similarly, other axes also have their own combinations.

Invalid remappings are signaled through the register INTERNAL_STATUS.axes_remap_error if an advanced feature is enabled.

Note:
The axis remapping applies only to the data fetched into the features. The DATA_0 to DATA_13 registers and FIFO are not affected and should be remapped accordingly on the driver level.

Configuration settings:

1. GEN_SET_1.map_x_axis – describes which axis shall be mapped to x axis.
2. GEN_SET_1.map_x_axis_sign – describes whether the mapped axis shall be inverted or not to be inverted.
3. GEN_SET_1.map_y_axis – describes which axis shall be mapped to y axis.
4. GEN_SET_1.map_y_axis_sign – describes whether the mapped axis shall be inverted or not to be inverted.
5. GEN_SET_1.map_z_axis – describes which axis shall be mapped to z axis.
6. GEN_SET_1.map_z_axis_sign – describes whether the mapped axis shall be inverted or not to be inverted.

Anymotion Detection

The anymotion detection uses the slope between two acceleration signals to detect changes in motion. The interrupt is configured by setting enable flag ANYMO_2.enable along with at least one of the following flags: ANYMO_1.select_x, ANYMO_1.select_y, and ANYMO_1.select_z respectively for each axis.

It generates an interrupt when the absolute value of the slope (the difference between two accelerations) exceeds the preset ANYMO_2.threshold for a certain number of consecutive data points ANYMO_1.duration.

The slope (difference) is being computed between the current acceleration sample and the reference sample. The reference sample is updated while the anymotion is detected; basically this means the reference is the last state when sensor detected Anymotion.

The interrupt generated will be reset as soon as the slope value falls below the threshold.

Configuration settings

1. ANYMO_2.enable – enable the feature.
2. ANYMO_1.duration – the number of consecutive data points for which the threshold condition must be respected, for interrupt assertion.
3. ANYMO_2.threshold – the slope threshold.
4. ANYMO_1.select_x – select the feature for x axis
5. ANYMO_1.select_y – select the feature for y axis
6. ANYMO_1.select_z – select the feature for z axis

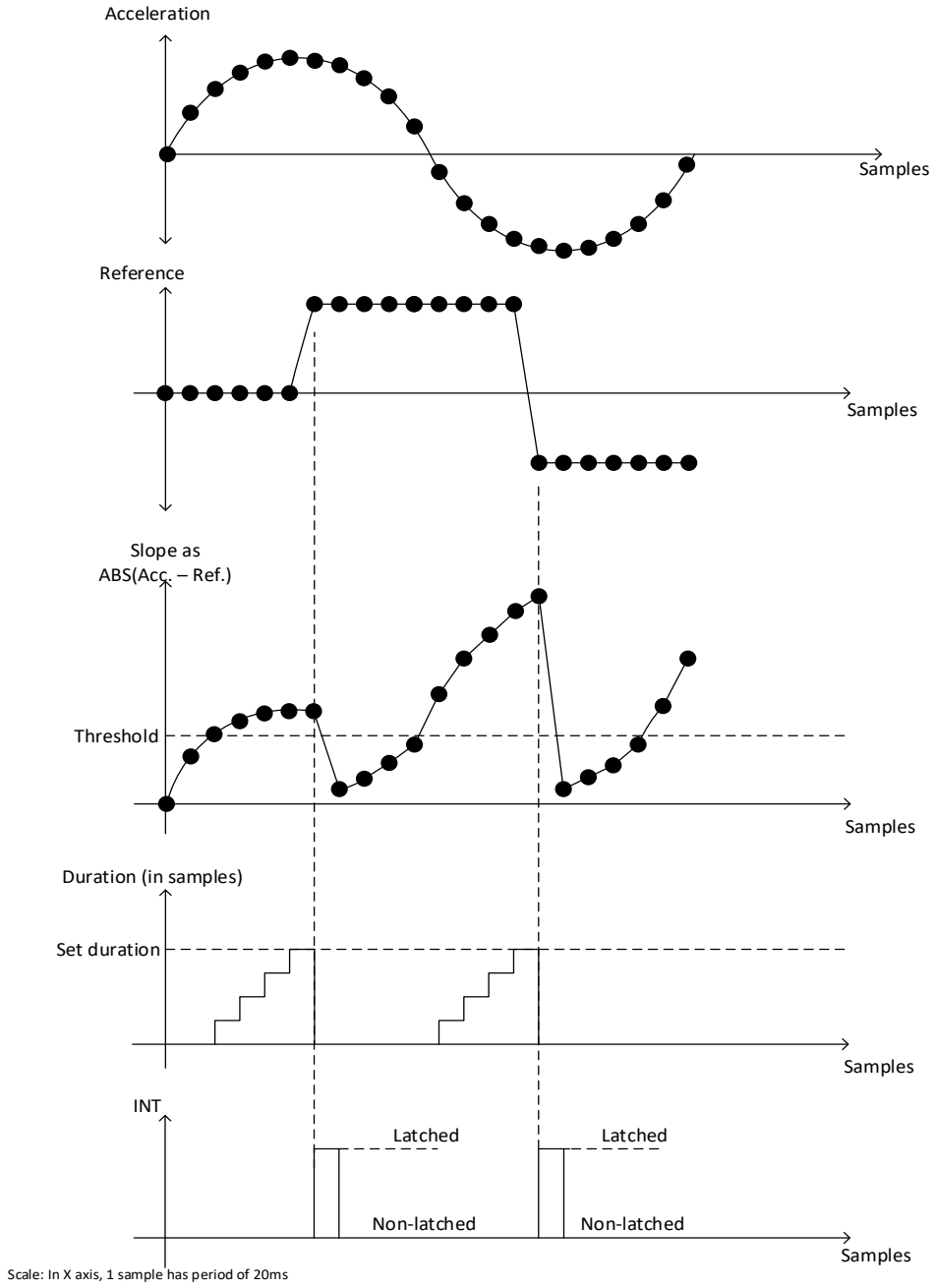


Figure 1: Any-motion detection

Nomotion Detection

The interrupt is configured by setting enable flag NOMO_2.enable along with at least one of the following flags: NOMO_1.select_x, NOMO_1.select_y, and NOMO_1.select_z respectively for each axis.

Nomotion Detection interrupt is generated when the slope on all selected axis remains smaller than a programmable NOMO_2.threshold for a programmable time. The signals and timings relevant to the nomotion interrupt functionality are depicted in the figure below.

Register NOMO_1.duration defines the number of consecutive slope data points of the selected axis which must exceed the threshold for an interrupt to be asserted.

Configuration settings

1. NOMO_2.enable – enable the feature.
2. NOMO_1.duration – the number of consecutive data points for which the threshold condition must be respected, for interrupt assertion.
3. NOMO_2.threshold – the slope threshold.
4. NOMO_1.select_x – select the feature for x axis
5. NOMO_1.select_y – select the feature for y axis
6. NOMO_1.select_z – select the feature for z axis

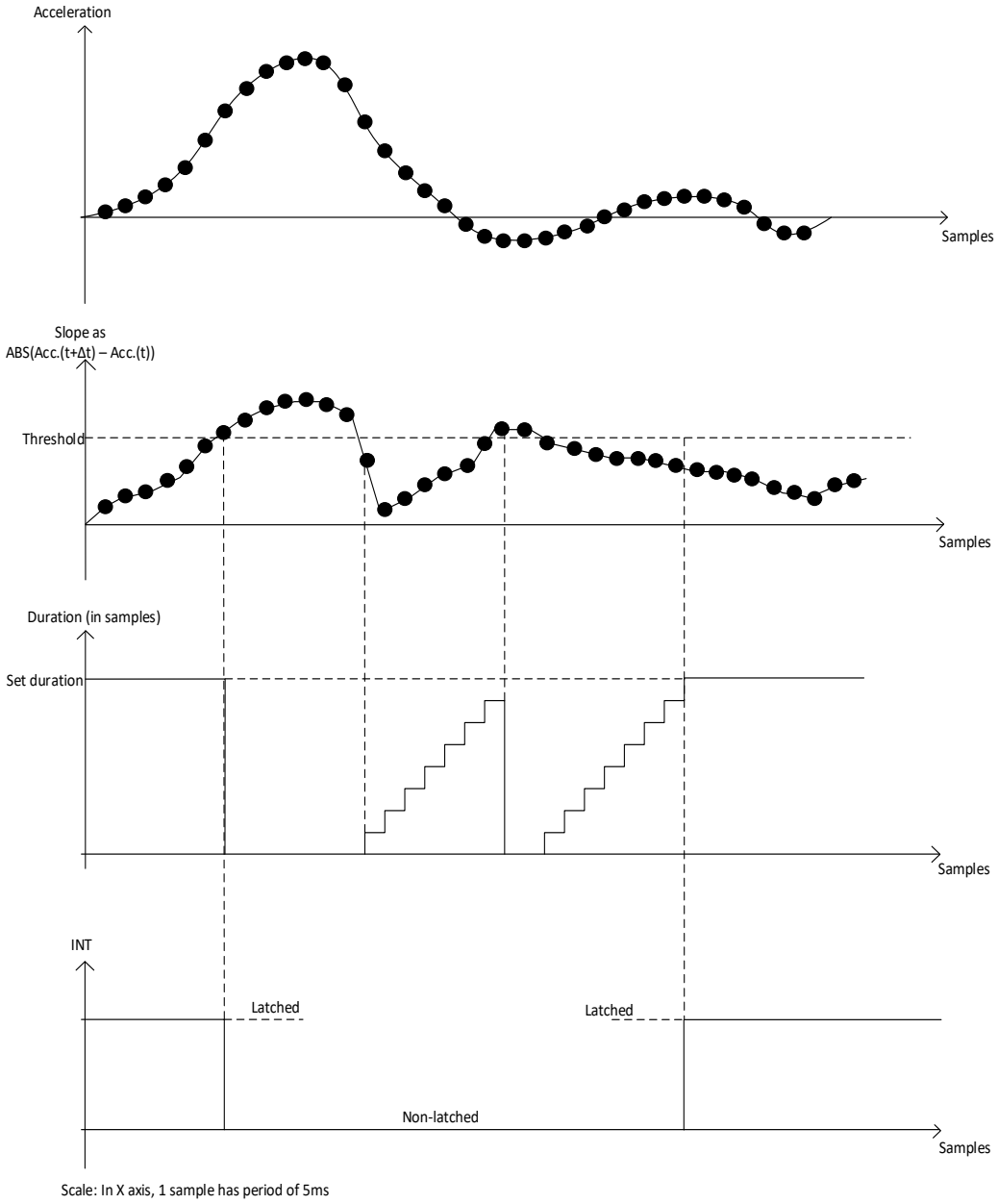


Figure 2: No-motion detection

Flat Detection

This interrupt detects Flat orientation. This interrupt triggers when the device gets close to horizontal position. This is expressed by the angle which the Z axis is making with gravitational acceleration.

The condition for activating the interrupt is:
Θ*acc_z * acc_z – Hysteresis > acc_x * acc_x + acc_y * acc_y

The condition to deactivate the interrupt is:
Θ*acc_z * acc_z + Hysteresis < acc_x * acc_x + acc_y * acc_y

If either of the inequalities is not respected then the interrupt keeps the previous value.
If other than +2/-2g range is selected, acceleration values are saturated before Flat computation.

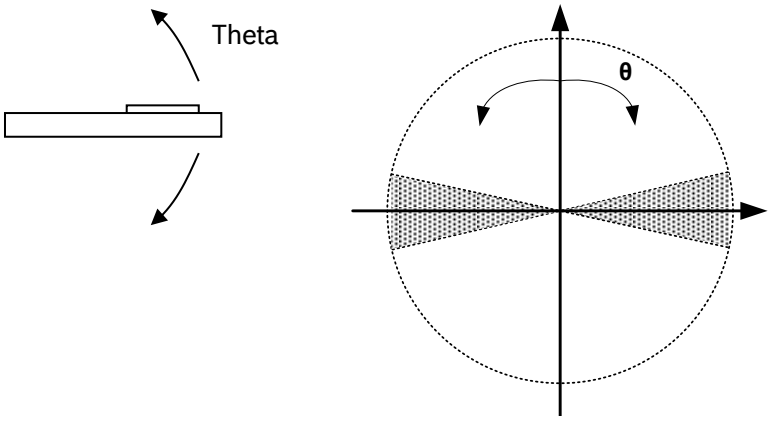


Figure 3: Flat Orientation Angles

Before the interrupt is actually changed (set or reset), the device must remain in this state for a certain period (e.g. FLAT_2.hold_time = 25 is equivalent to 25 samples recorded at 50Hz = 0.5 seconds).

Θ Angle

The threshold angle for detecting Flat state is expressed in 64*(tan(angle)^2). Some important values of FLAT_1.theta are depicted in the next table.

Θ numeric value	**Angle (degrees)**
0	0.0
1	7.1
2	10.0
5	15.6
8	19.5
14	25.1
22	30.4
33	35.7
45	40.0
63	44.8

Table 1: Flat Θ correspondence in degrees

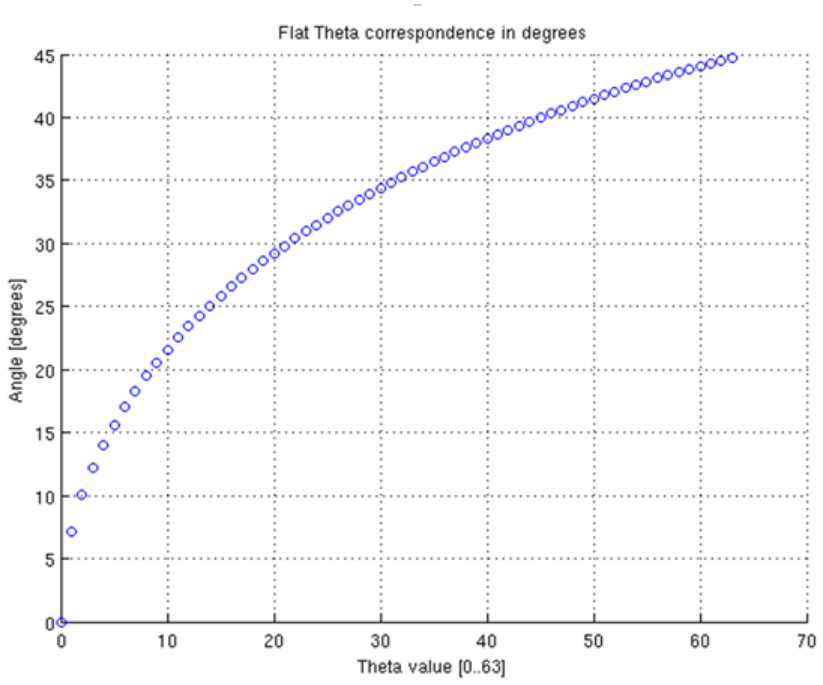


Figure 4: Θ angle

Hysteresis

The Flat detection Θ angle has an associated Hysteresis.

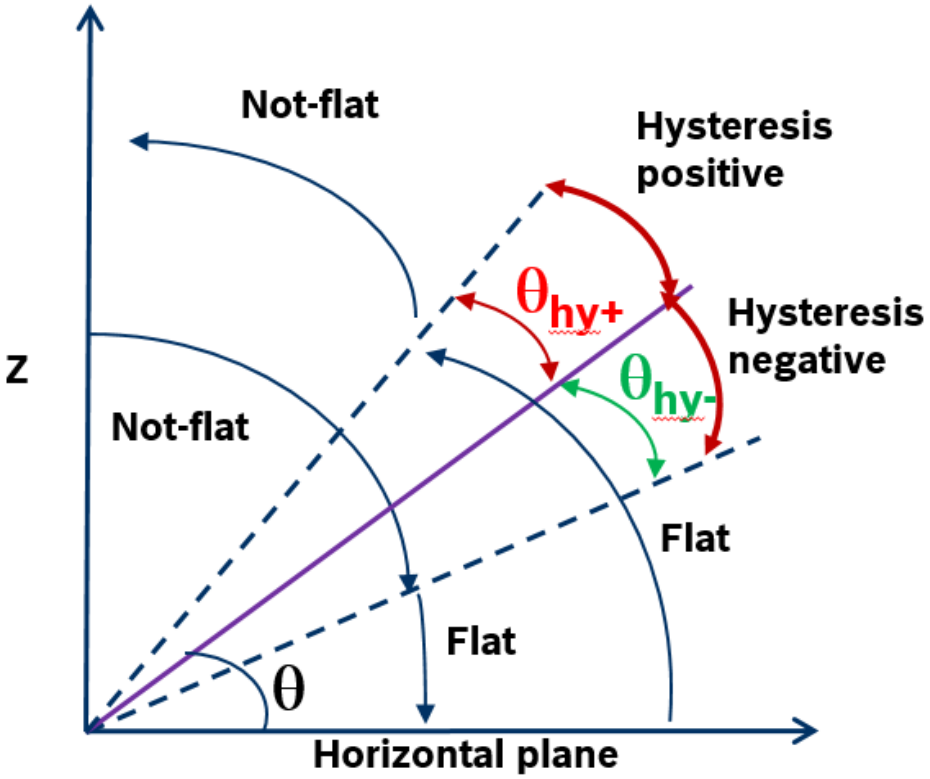


Figure 5: Hysteresis and Θ angle

The value of the FLAT_2.hysteresis is set according to the following graphic, with values between 0 and 63, which corresponds to hysteresis angle between 0 and 5 degrees. In the following graphic, 4 usual cases are depicted: 0, 1, 2.5 and 5 degrees.

The hysteresis is symmetric, used for both going into and out of Flat state. For the default value of 9, the actual interval around the Θ 20 degrees is +/-2.5 degrees; so a 5 degree interval is used for total Hysteresis filtering.

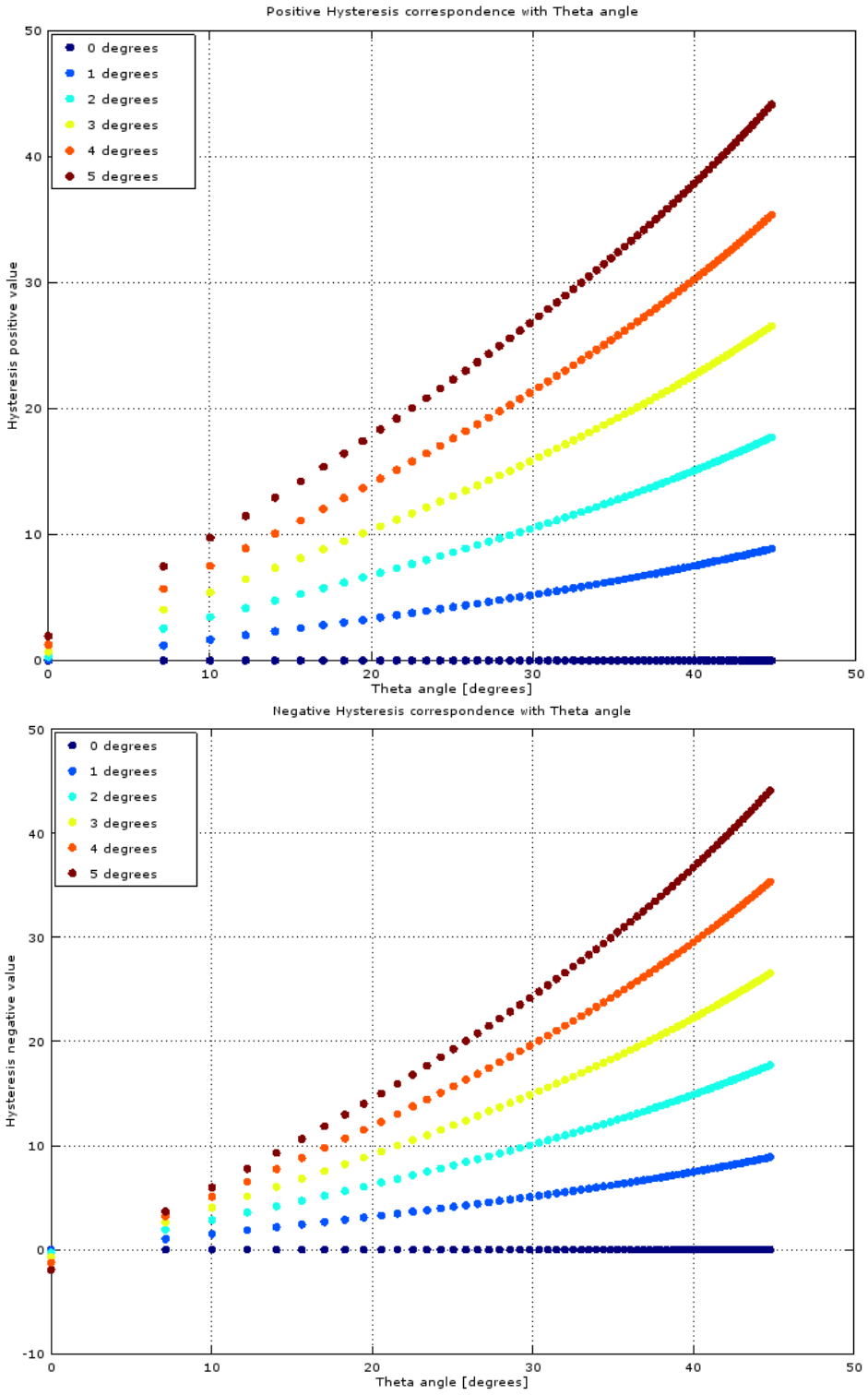


Figure 6: Hysteresis and Θ angle

Blocking mode

It is possible to block the Flat detection change. The Flat detection interrupt blocking feature is configurable via the FLAT_1.blocking and has the following meaning:

Blocking	**Conditions**
00	Interrupt blocking is disabled
01	acceleration of any axis > 1.5g
10	acceleration of any axis > 1.5g OR Slope>0.2g
11	Interrupt blocking is disabled

Table 2: Flat detection blocking

Configuration settings

1. FLAT_1.enable – indicates if this feature is enabled or not.
2. FLAT_1.theta – coded value of angle with horizontal; θ = 64 * (tan(angle)^2); default value is 8, equivalent to 20 degrees angle.
3. FLAT_2.hysteresis – the Θ angle hysteresis.
4. FLAT_1.blocking – sets the blocking mode.
5. FLAT_2.hold_time – holds the duration for which the condition has to be respected.

High-g Detection

This interrupt is enabled by setting enable flag HI_G_2.enable along with at least one axis.

The interrupt is asserted if the absolute value of acceleration data of at least one enabled axis exceeds the programmed HI_G_1.threshold and the sign of the value does not change for a minimum HI_G_3.duration.

The interrupt condition is cleared when the absolute value of acceleration data of all selected axes falls below the HI_G_1.threshold minus the HI_G_2.hysteresis or if the sign of the acceleration value changes.

If any device axis is parallel to the gravitational vector, then that axis will report ±1g as output. In this case, it is recommended to have (*threshold* - *hysteresis*) greater than 1g. If (*threshold* - *hysteresis*) is less than 1g then after high-g interrupt is triggered, the interrupt will not get cleared if anyone axis is parallel to the gravitational vector since that axis will already be at 1g.

The X, Y and Z axes are enabled with the HI_G_2.select_x, HI_G_2.select_y, and HI_G_2.select_z respectively.When the high-g interrupt is triggered, the signals of the axis that has triggered the interrupt (*first_x*, *first_y*, *first_z*) and the motion direction (*sign*) are set.

Configuration settings

1. HI_G_3.duration – the duration in 200 Hz samples (5ms) for which the threshold has to be exceeded.
2. HI_G_2.hysteresis – the detection hysteresis.
3. HI_G_2.select_x – select the feature for x axis
4. HI_G_2.select_y – select the feature for y axis
5. HI_G_2.select_z – select the feature for z axis
6. HI_G_2.enable – enable the feature
7. HI_G_1.threshold – the detection threshold.

Output

1. High g output is packed only in FEATURE page as shown in below,
2. high_g_detect_x - bit 3 , this is set if high-g was detected on x axis
3. high_g_detect_y - bit 4, this is set if high-g was detected on y axis
4. high_g_detect_z - bit 5, this is set if high-g was detected on z axis
5. high_g_detect_sign - bit 6, this reflects the sign of the acceleration for which the high-g was detected; 1 – negative, 0 – positive.

The output of the features are provided via the ORIENT_HI_G_OUT registers. The outputs are updated whenever a new event triggered, e.g. for the high g interrupt the axes information is only updated when then high g event condition is satisfied. This avoids that the feature output is gone, when the host is late reading it.

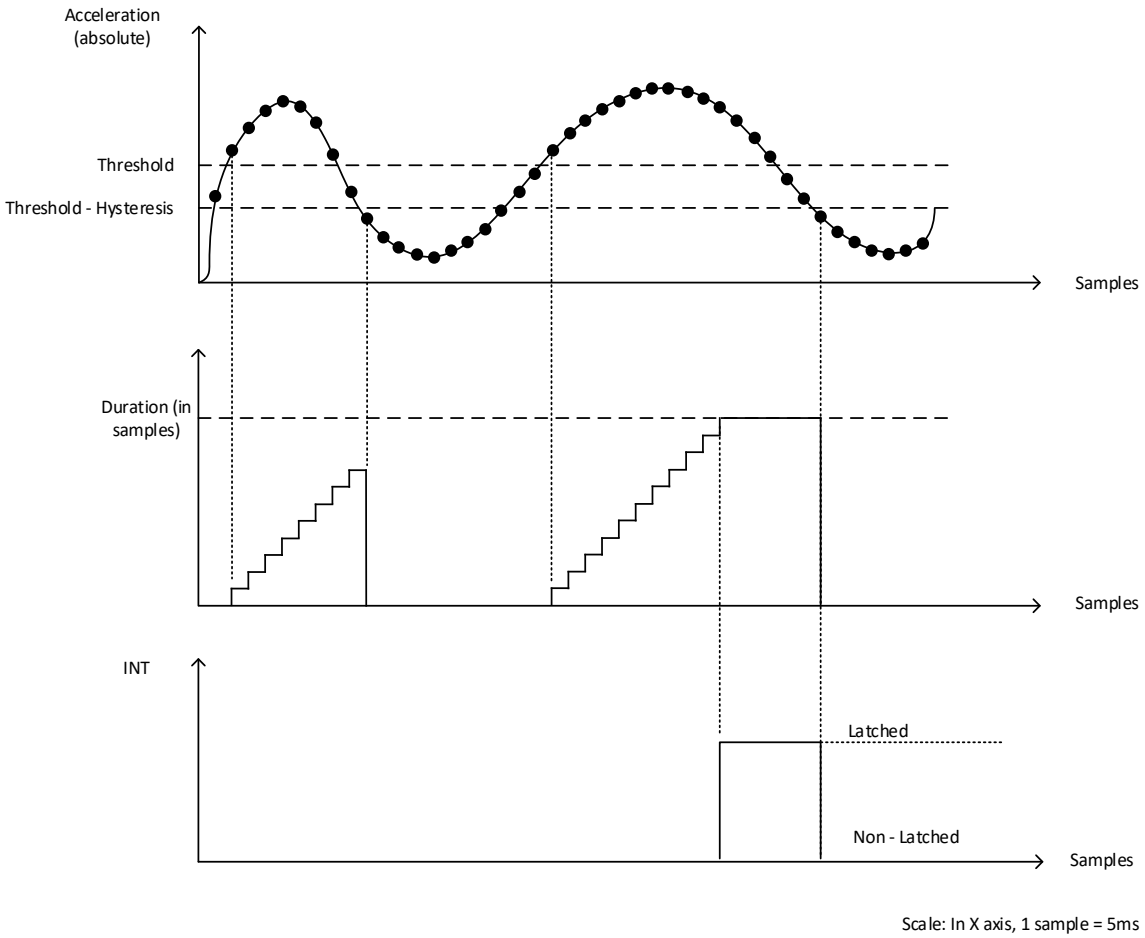


Figure 7: High G detection

Low-g (Freefall) Detection

For freefall detection, the absolute values of the acceleration data of all axes are observed. The vector length of all accelerations, sqrt(acc_x^2 + acc_y^2 + acc_z^2), is compared with the LO_G_1.threshold.

The interrupt will be generated when the acceleration is smaller than threshold for some minimum number of samples (LO_G_3.duration). The interrupt is reset when the acceleration is above the Threshold + Hysteresis value.

Configuration settings

1. LO_G_1.threshold – the detection threshold.
2. LO_G_2.hysteresis – the detection hysteresis.
3. LO_G_3.duration – the duration in 50 Hz samples (20ms) for which the threshold has to be exceeded.
4. LO_G_2.enable – indicates if this feature is enabled or not.

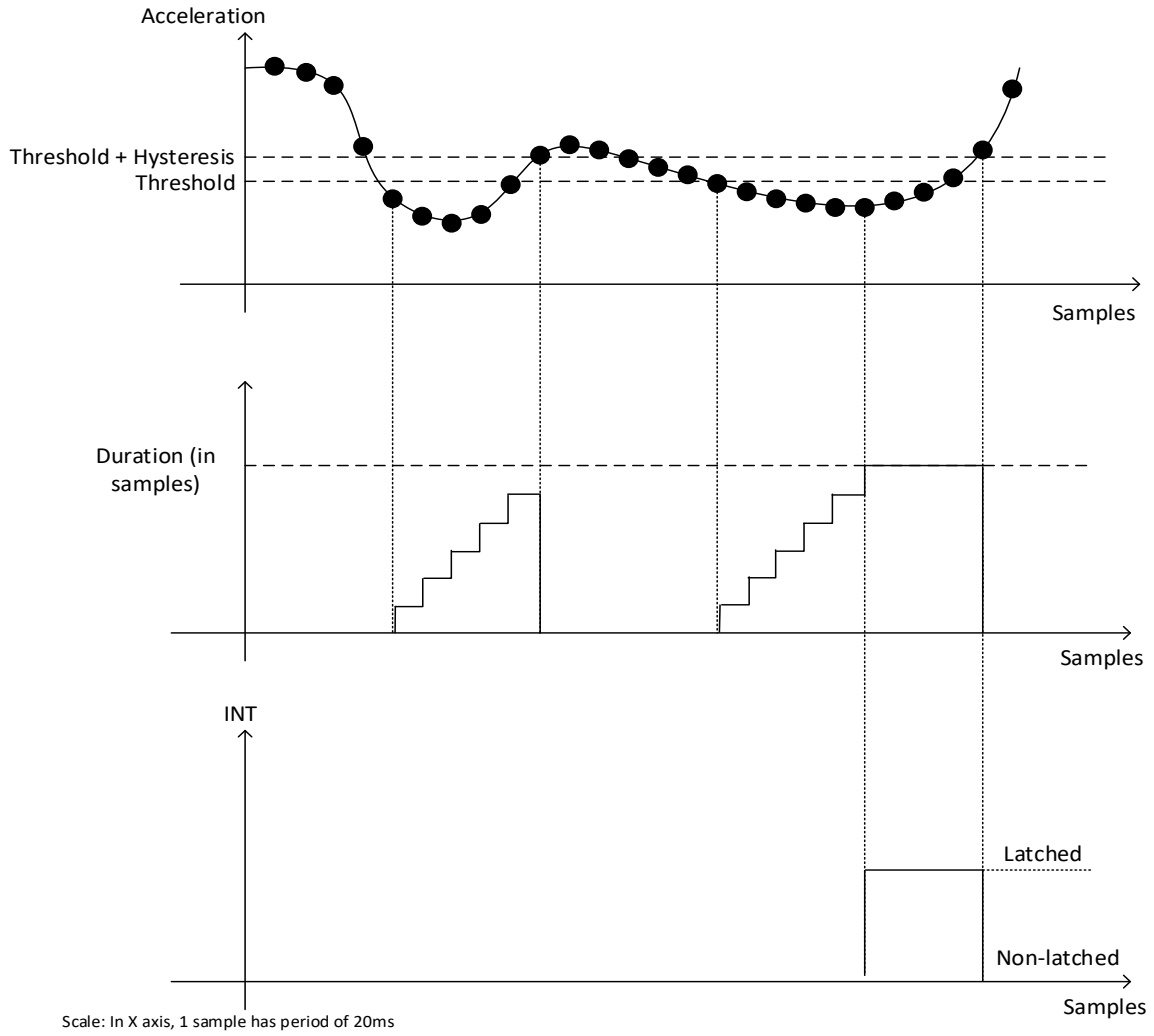


Figure 8: Low G detection

Orientation Detection

The orientation recognition feature informs on an orientation change of the sensor with respect to the gravitational field vector g. There are the orientations face up/face down and orthogonal to that portrait upright, landscape left, portrait downside, and landscape right. The interrupt for face up/face down may be enabled separately through ORIENT_1.ud_en.

The sensor orientation is defined by the angles φ (phi) and θ (theta). φ is the rotation around the stationary z axis, θ is the rotation around the stationary y axis (before φ rotation).

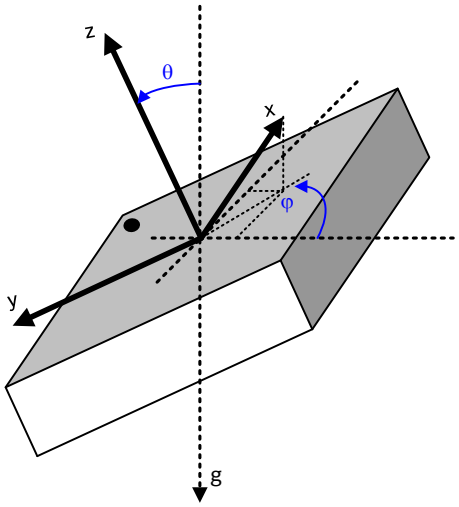


Figure 9: Definition of coordinate system with respect to pin 1 marker

The measured acceleration vector components look as follows:

(1) $acc\_x = 1g \cdot \sin\theta \cdot \cos\varphi$
(2) $acc\_y = -1g \cdot \sin\theta \cdot \sin\varphi$
(3) $acc\_z = 1g \cdot \cos\theta$
(2) / (1) → $acc\_y/acc\_x = -\tan\varphi$

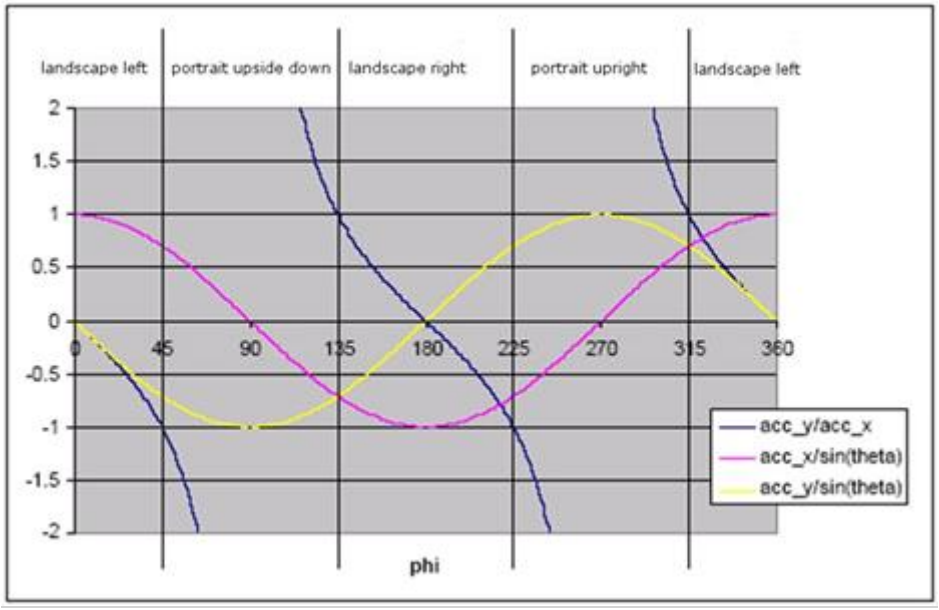


Figure 10: Angle-to-Orientation Mapping

Note that the sensor measures the direction of the force which needs to be applied to keep the sensor at rest (i.e. opposite direction than g itself).

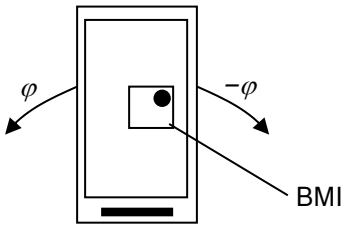


Figure 11: Looking at phone device from frontside/portrait upright (φ = 90°, θ = 270°)

The orientation value is stored in the output register. There are three orientation calculation modes: symmetrical, high-asymmetrical and low-asymmetrical. The mode is selected by the register ORIENT_1.mode as follows:

ORIENT_1.mode	**Orientation mode**
00	Symmetrical
01	High asymmetrical
10	Low asymmetrical
11	Symmetrical

Table 3: Orientation Mode: Symmetrical or Asymmetrical

The output has the following meanings depending on the switching mode:

Orient	**Name**	**Angle**	**Condition**
x01	landscape left	315°<φ<45°	|acc_y/acc_x|<1 && acc_x≥0
x11	landscape right	135°<φ<225°	|acc_y/acc_x|<1 && acc_x<0
x10	portrait upside down	45°<φ<135°	|acc_y/acc_x|≥1 && acc_y<0
x00	portrait upright	225°<φ<315°	|acc_y/acc_x|≥1 && acc_y≥0

Table 4: Symmetrical mode

Orient	**Name**	**Angle**	**Condition**
x01	landscape left	297°<φ<63°	|acc_y/acc_x|<2 && acc_x≥0
x11	landscape right	117°<φ<243°	|acc_y/acc_x|<2 && acc_x<0
x10	portrait upside down	63°<φ<117°	|acc_y/acc_x|≥2 && acc_y<0
x00	portrait upright	243°<φ<297°	|acc_y/acc_x|≥2 && acc_y≥0

Table 5: High asymmetrical mode

Orient	**Name**	**Angle**	**Condition**
x01	landscape left	333°<φ<27°	|acc_y/acc_x|<0.5 && acc_x≥0
x11	landscape right	153°<φ<207°	|acc_y/acc_x|<0.5 && acc_x<0
x10	portrait upside down	27°<φ<153°	|acc_y/acc_x|≥0.5 && acc_y<0
x00	portrait upright	207°<φ<333°	|acc_y/acc_x|≥0.5 && acc_y≥0

Table 6: Low asymmetrical mode

For upside or downside orientation, the respective bit of output has the definition:

ORIENT_HI_G_OUT.faceup_down / ORIENT_ACT.faceup_down	acc_z
value 0 = upside	(270° < θ < 90°) → *acc_z >= 0*
value 1 = downside	(90° < θ < 270°) → *acc_z < 0*

Table 7: Upside/Downside definition

Both portrait/landscape and upside/downside recognition use a ORIENT_2.hysteresis. The hysteresis for portrait/landscape detection is configurable and applies to all conditions as described in the tables below.

orient	Name	Angle	Condition
x01	landscape left	315°+hy <φ< 45°-hy	|acc_y|<|acc_x|-hyst && acc_x≥0
x11	landscape right	135°+hy <φ< 225°-hy	|acc_y|<|acc_x|-hyst && acc_x<0
x10	portrait upside down	45°+hy <φ< 135°-hy	|acc_y|>|acc_x|+hyst && acc_y<0
x00	portrait upright	225°+hy <φ< 315°-hy	|acc_y|>|acc_x|+hyst && acc_y≥0

Table 8: Symmetrical mode

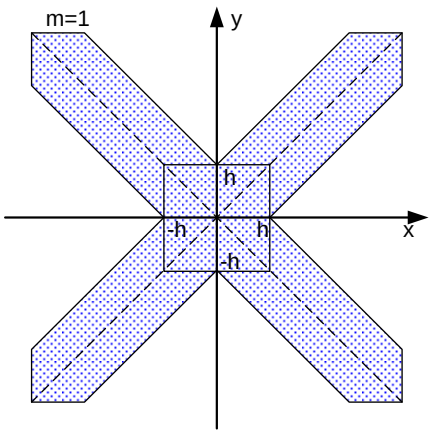


Figure 12: Hysteresis in symmetrical mode

orient	Name	Angle	Condition
x01	landscape left	297°+hy <φ<63°-hy	|acc_y|<2*(|acc_x|-hyst) && acc_x≥0
x11	landscape right	117°+hy <φ<243°-hy	|acc_y|<2*(|acc_x|-hyst) && acc_x<0
x10	portrait upside down	63°+hy <φ<117°-hy	|acc_y|>2*|acc_x|+hyst && acc_y<0
x00	portrait upright	243°+hy <φ<297°-hy	|acc_y|>2*|acc_x|+hyst && acc_y≥0

Table 9: High asymmetrical mode

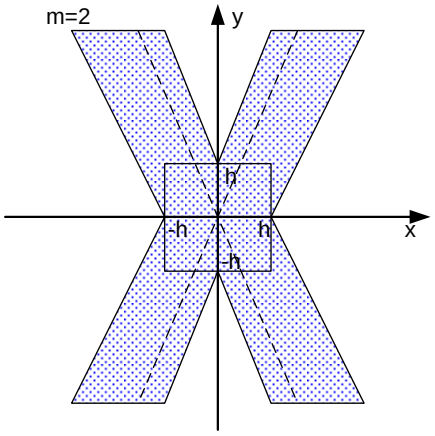


Figure 13: Hysteresis in high asymmetrical mode

orient	Name	Angle	Condition
x01	landscape left	333°+hy <φ<27°-hy	|acc_y|<(|acc_x|-hyst)/2 && acc_x≥0
x11	landscape right	153°+hy <φ<207°-hy	|acc_y|<(|acc_x|-hyst)/2 && acc_x<0
x10	portrait upside down	27°+hy <φ<153°-hy	|acc_y|>|acc_x|/2+hyst && acc_y<0
x00	portrait upright	207°+hy <φ<333°-hy	|acc_y|>|acc_x|/2+hyst && acc_y≥0

Table 10: Low asymmetrical mode

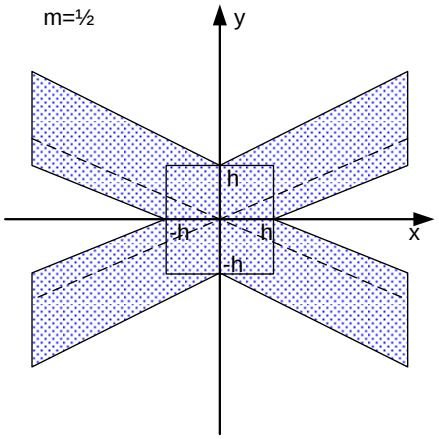


Figure 14: Hysteresis in low asymmetrical mode

The hysteresis for upside/downside detection is fixed to 11.5° which is ~200 mg.

orient	Name	Angle	Condition
0xx	upside	281.5°<Θ<78.5°	acc_z>200mg (|acc_z|>200mg and acc_z≥0)
1xx	downside	101.5°<φ<258°	acc_z<-200mg (|acc_z|>200mg and acc_z<0)

Table 1 Upside/downside hysteresis

Blocking mode

The orientation blocking mode feature may be used to avoid undesired orientation changes detection interrupts, e.g. if the device is nearly flat or in motion. The configuration of the blocking mode is performed in the ORIENT_1.blocking register:

Blocking	Conditions
00	Interrupt blocking is disabled
01	Interrupt blocked if device close to the horizontal position (θ_flat) OR acceleration of any axis > 1.5g
10	Interrupt blocked if device close to the horizontal position (θ_flat) OR acceleration of any axis > 1.5g OR slope>0.2g
11	Interrupt blocked if device close to the horizontal position (θ_flat) OR acceleration of any axis > 1.5g OR slope > 0.4g OR another change within 100ms

Table 2: Orientation blocking

If the 100ms interrupt blocking is enabled (blocking mode '11'), to trigger the interrupt, the detected orientation has to remain the same (stable) until the timer expires (for ~100ms).

The timer starts to count when orientation changes between two consecutive samples. If the orientation changes while timer is still counting, the timer is restarted.
The θ blocking (phone close to the horizontal position) is defined by inequality presented in Flat Detection section. If other than +2/-2g range is selected, acceleration values are saturated before flat detection for blocking modes.

Configuration settings

1. ORIENT_1.mode – used for setting which of the following modes are being used: symmetrical, high or low asymmetrical
2. ORIENT_1.blocking – used for setting the blocking mode.
3. ORIENT_1.theta – coded value of the threshold angle with horizontal used in Blocking modes; θ = 64 * (tan(angle)^2.
4. ORIENT_2.hysteresis - acceleration hysteresis for Orientation detection.
5. ORIENT_1.enable – indicates if this feature is enabled or not.
6. ORIENT_1.ud_en – face upside/downside enable, in addition to landscape/portrait detection.

Orientation output

There are 3 bits:

1. Bit 2 (ORIENT_HI_G_OUT.faceup_down or ORIENT_ACT.faceup_down) reflects the face-up (value 0), respectively face-down (value 1), only if ud_en is enabled.
2. Bit 0-1 (ORIENT_HI_G_OUT.portrait_landscape or ORIENT_ACT.portrait_landscape) have the value:
    1. portrait_upright = 0
    2. landscape_left = 1
    3. portrait_upside_down = 2
    4. landscape_right = 3

Tap Detection

The gesture „Tap“, “Double Tap”, or “Triple Tap” selected in TAP_1 can be used to trigger an interrupt event. The tap is triggered by the acceleration along the axis configured in TAP_6.axis_sel (default z axis). Using the register TAP_2.tap_sens_thres the sensitivity can be customized from 0 (high sensitive) to 7 (low sensitive).

Configuration settings

1. TAP_1.single_tap_en – Enable the detection of single-tap gesture.
2. TAP_1.double_tap_en – Enable the detection of double-tap gesture.
3. TAP_1.triple_tap_en – Enable the detection of triple-tap gesture.
4. TAP_1.data_reg_en - By enabling this bit, accel data according to the user defined accel configuration is taken for tap detector feature (ODR must be set to 200Hz for the use of tap detector feature). When this bit is disabled, 200Hz unfiltered accel data is used for tap detector feature.
5. TAP_2.tap_sens_thres – Scaling factor of additional threshold increment for detection of positive and negative peak of a tap. Default value = 3, Recommended range = 0 to 15. Resolution of each LSB of scaling factor in terms of filtered acceleration signal magnitude is 78.125 mg.
6. TAP_3.max_gest_dur - Maximum duration after the first tap within which the second and/or third tap have to be performed for being detected as double-tap or triple-tap. Default value = 80 (400 ms), Resolution = 5 ms, Recommended range = 250 to 1000 ms.
7. TAP_4.quite_time_after_gest - Minimum quite time between the two gesture detection. Default value = 80 (400 ms), Resolution = 5 ms, Recommended range = 250 to 500 ms
8. TAP_5.wait_for_timeout - Wait for the duration set by TAP_3.max_gest_dur after the first tap and report the tap-gesture based on number of taps detected. Default value = 0 (disabled). Allowed values = 0 / 1 (disabled / enabled).
9. TAP_6.axis_sel - Selection of axis from 3D-acceleration signal vector for tap detection. Default value = 2 (z-axis). Other supported values 0 (x-axis) and 1 (y-axis). Any other selection leads to usage of default value.

Output

Once the tap interrupt is triggered, the corresponding status shall be referred from ORIENT_ACT.s_tap_out, ORIENT_ACT.d_tap_out and ORIENT_ACT.t_tap_out.

Significant Motion Detection

The significant motion interrupt implements the interrupt required for motion detection in Android 4.3 and greater: https://source.android.com/devices/sensors/sensor-types.html#significant_motion.

A significant motion is a motion due to a change in the user location.

Examples of such significant motions are walking or biking, sitting in a moving car, coach or train, etc. Examples of situations that does typically not trigger significant motion include phone in pocket and person is stationary or phone is at rest on a table which is in normal office use.

Configuration settings

1. SIGMO_2.enable – indicates if this feature is enabled or not.
2. SIGMO_1.block_size – Defines the duration after which the significant motion interrupt is triggered. It is expressed in 50 Hz samples (20 ms). Default value is 0xFA=5sec.

Step counter / Step Detector

The Step Counter implements the function required for step counting in Android 4.4 and greater: https://source.android.com/devices/sensors/sensor-types.html#step_counter.

The Step Detector implements the function required for step counting in Android 4.4 and greater: https://source.android.com/devices/sensors/sensor-types.html#step_detector.

The stepcounter algorithm is designed for smartphone usecases[2] and optimized on high accuracy, while step detector is optimized on low latency. Each can be enabled independently, but the step detector interrupt output is mutually exclusive with the step counter watermark interrupt.

Configuration settings

1. SC_1.watermark_level - Watermark level; the Step-counter will trigger output every time this number of steps are counted. Holds implicitly a 20x factor, so the range is 0 to 1023 (without the implicit factor), with resolution of 20 steps. If 0, the Step Counter watermark is disabled. If Step Detector is enabled, the watermark interrupt is disabled (as being mutually exclusive).
2. SC_1.reset_counter – flag to reset the counted steps. Resets the step count value, if any one of step counter, step detector or activity feature is enabled.
3. SC_1.en_counter – indicates if the step counter feature is enabled or not.
4. SC_1.en_detector – indicates if the step detector feature is enabled or not.

The step counter accumulates the steps detected by the step detector interrupt, and makes available the 32 bit current step counter value in the following 4 registers, each holding 8 bit: SC_OUT_0_1.byte_0 (LSB), SC_OUT_0_1.byte_1, SC_OUT_2_3.byte_2, and SC_OUT_2_3.byte_3 (MSB).

By enabling the SC_1.reset_counter flag, the accumulated step number value is reset. Afterwards, the value of this flag is automatically reset and counting is restarted. Accumulated step count value can be reset when any one of step counter, step detector or activity feature is enabled.

[2] For wearable use-case optimized stepcounter refer to the one in BMI270 datasheet

Step Counter

The watermark option can be useful if the host needs to receive an interrupt every time a certain number of steps occured. If SC_1.watermark_level is set to 10 (holding an implicit factor of 20x), every 200 steps are counted an interrupt will be raised on INT_STATUS_0.step_counter_out. As the steps are buffered internally, the output may be triggered between 200-210 steps. The exact number of steps recorded is available in the registers SC_OUT_0_1.byte_0, SC_OUT_0_1.byte_1, SC_OUT_2_3.byte_2, and SC_OUT_2_3.byte_3. When the watermark level is reached, the corresponding interrupt bit is asserted INT_STATUS_0.step_counter_out.

Step Detector

If SC_1.en_detector is set, an interrupt is triggered for every step detected. So, every time a new step is detected, it asserts the corresponding interrupt output INT_STATUS_0.step_counter_out. In this case, the Step Detector feature is optimized on low latency, so when a step is detected, it is immediately signaled. Due to this functionality, there are situations when sum of the detected steps is different than the step counting value.

Step Counter result publication

Step counter results are available in (4 bytes counter value)

SC_OUT_0_1.byte_0, SC_OUT_0_1.byte_1, SC_OUT_2_3.byte_2, and SC_OUT_2_3.byte_3

and in (2 bytes counter value)

SC_OUT_0.byte_0 and SC_OUT_1.byte_1

The 4 byte counter value is only accessible if the device is not in low power or suspend mode.

Activity and Activity Change Recognition

The device can detect simple[3] user activities (unknown, still, walking, running) and can send an interrupt if those are changed, e.g. from walking to running or vice versus. The interrupt is shared with step detector/step counter watermark interrupts and can be configured independently of all other interrupts to any of the interrupt lines.

1. The device reports changes for following activity changes by an interrupt
    1. Still - 0
    2. Walking - 1
    3. Running -2
    4. Unknown – 3
2. Activity interrupt will be triggered only when there is change in status
3. ACT_OUT.act_out reports the activity status

During power on, activity will be unknown (0x03) and the device receives an activity change interrupt once activity is enabled, and a new activity detected. When activity is disabled, status will be changed to unknown.

Configuration settings

1. SC1_1.en_activity – indicates if the activity feature is enabled or not

[3] A sophisticated activity recognition engine is implemented in BMI270 Context version for wearable use-cases

4. Register Description

4.1. General Remarks

This section contains register definitions. REG[x]<y> denotes bit y in byte x in register REG. Val(Name) is the value contained in the register interpreted as non-negative binary number. When writing to reserved bits, '0' should be written if not stated different.

For most of the registers auto address increment applies for, with the exception of the registers below, which trap the address:

- FIFO_DATA
- INIT_DATA

Register read from a burst read must remain consistent. In order to ensure this, when a read starts in one register of a group, the registers in this group are shadowed:

- STATUS, DATA_x, SENSORTIME_x, TEMPERATURE_x, FIFO_LENGTH_x

The registers listed below are clear-on-read:

- ERR_REG
- STATUS.drdy_acc (cleared when DATA_9.acc_x_15_8 is read),
- STATUS.drdy_gyr (cleared when DATA_15.gyr_x_15_8 is read)
- STATUS.drdy_aux (cleared when DATA_1.aux_x_15_8 is read)
- EVENT
- INT_STATUS_0
- INT_STATUS_1

The register clearance happens, when bit 0 of the corresponding register is read.

4.2. Register Map

read/write	read only	write only	reserved

Corresponding to BMI270L_image.tbin version 4.0, register map version 4.0

Register Address	Register Name	Default Value	7	6	5	4	3	2	1	0
0x7E	CMD	0x00	cmd							
0x7D	PWR_CTRL	0x00	reserved				temp_en	acc_en	gyr_en	aux_en
0x7C	PWR_CONF	0x03	reserved					fup_en	fifo_self_wake_up	adv_power_save
0x7B	-	-	reserved							
...	-	-	reserved							
0x78	-	-	reserved							
0x77	OFFSET_6	0x00	gyr_gain_en	gyr_off_en	gyr_usr_off_z_9_8		gyr_usr_off_y_9_8		gyr_usr_off_x_9_8	
0x76	OFFSET_5	0x00	gyr_usr_off_z_7_0							
0x75	OFFSET_4	0x00	gyr_usr_off_y_7_0							
0x74	OFFSET_3	0x00	gyr_usr_off_x_7_0							
0x73	OFFSET_2	0x00	off_acc_z							
0x72	OFFSET_1	0x00	off_acc_y							
0x71	OFFSET_0	0x00	off_acc_x							
0x70	NV_CONF	0x00	reserved				acc_off_en	i2c_wdt_en	i2c_wdt_sel	spi_en
0x6F	-	-	reserved							
0x6E	GYR_SELF_TEST_AXES	0x00	reserved				gyr_axis_z_ok	gyr_axis_y_ok	gyr_axis_x_ok	gyr_st_axes_done
0x6D	ACC_SELF_TEST	0x00	reserved				acc_self_test_amp	acc_self_test_sign	reserved	acc_self_test_en
0x6C	DRV	0xFF	io_pad_i2c_b2	io_pad_drv2			io_pad_i2c_b1	io_pad_drv1		
0x6B	IF_CONF	0x00	reserved		aux_en	ois_en	reserved		spi3_ois	spi3
0x6A	NVM_CONF	0x00	reserved						nvm_prog_en	reserved

0x69	GYR_CRT_CONF	0x00	reserved				rdy_for_dl	crt_running	reserved
0x68	AUX_IF_TRIM	0x01	reserved						asda_pupsel
0x67	-	-	reserved						
...	-	-	reserved						
0x60	-	-	reserved						
0x5F	INTERNAL_ERROR	0x00	reserved			feat_eng_disabled	reserved	int_err_2	int_err_1	reserved
0x5E	INIT_DATA	0x00	data						
0x5D	-	-	reserved						
0x5C	INIT_ADDR_1	0x00	base_11_4						
0x5B	INIT_ADDR_0	0x00	reserved				base_0_3		
0x5A	-	-	reserved						
0x59	INIT_CTRL	0x00	init_ctrl						
0x58	INT_MAP_DATA	0x00	err_int2	drdy_int2	fwm_int2	ffull_int2	err_int1	drdy_int1	fwm_int1	ffull_int1
0x57	INT2_MAP_FEAT	0x00	orientation_out	any_motion_out	no_motion_out	flat_out	tap_out	high_low_g_out	step_counter_out	sig_motion_out
0x56	INT1_MAP_FEAT	0x00	orientation_out	any_motion_out	no_motion_out	flat_out	tap_out	high_low_g_out	step_counter_out	sig_motion_out
0x55	INT_LATCH	0x00	reserved							int_latch
0x54	INT2_IO_CTRL	0x00	reserved			input_en	output_en	od	lvl	reserved
0x53	INT1_IO_CTRL	0x00	reserved			input_en	output_en	od	lvl	reserved
0x52	ERR_REG_MSK	0x00	aux_err	fifo_err	reserved	internal_err				fatal_err
0x51	-	-	reserved							
0x50	-	-	reserved							
0x4F	AUX_WR_DATA	0x02	write_data							
0x4E	AUX_WR_ADDR	0x4C	write_addr							
0x4D	AUX_RD_ADDR	0x42	read_addr							

0x4C	AUX_IF_CONF	0x83	aux_manual_en	aux_fcu_write_en	reserved		man_rd_burst	aux_rd_burst
0x4B	AUX_DEV_ID	0x20	i2c_device_addr					reserved
0x4A	SATURATION	0x00	reserved		gyr_z	gyr_y	gyr_x	acc_z	acc_y	acc_x
0x49	FIFO_CONFIG_1	0x10	fifo_gyr_en	fifo_acc_en	fifo_aux_en	fifo_header_en	fifo_tag_int2_en		fifo_tag_int1_en	
0x48	FIFO_CONFIG_0	0x02	reserved						fifo_time_en	fifo_stop_on_full
0x47	FIFO_WTM_1	0x02	reserved				fifo_water_mark_12_8			
0x46	FIFO_WTM_0	0x00	fifo_water_mark_7_0							
0x45	FIFO_DOWNS	0x88	acc_fifo_filt_data	acc_fifo_downs			gyr_fifo_filt_data	gyr_fifo_downs		
0x44	AUX_CONF	0x46	aux_offset				aux_odr			
0x43	GYR_RANGE	0x00	reserved				ois_range	gyr_range		
0x42	GYR_CONF	0xA9	gyr_filter_perf	gyr_noise_perf	gyr_bwp		gyr_odr			
0x41	ACC_RANGE	0x02	reserved						acc_range	
0x40	ACC_CONF	0xA8	acc_filter_perf	acc_bwp			acc_odr			
0x3F	FEATURES[15]	0x00	features_in_out							
...	...	-								
0x30	FEATURES[0]	0x00								
0x2F	FEAT_PAGE	0x00	reserved					page		
0x2E	-	-	reserved							
...	-	-	reserved							
0x27	-	-	reserved							
0x26	FIFO_DATA	0x00	fifo_data							
0x25	FIFO_LENGTH_1	0x00	reserved	fifo_byte_counter_13_8						
0x24	FIFO_LENGTH_0	0x00	fifo_byte_counter_7_0							

0x23	TEMPERATURE_1	0x80	tmp_data_15_8						
0x22	TEMPERATURE_0	0x00	tmp_data_7_0						
0x21	INTERNAL_STATUS	0x00	odr_high_error	odr_50hz_error	axes_remap_error	Reserved	message		
0x20	ORIENT_ACT	0x00	t_tap_out	d_tap_out	s_tap_out	act_out		faceup_down	portrait_landscape
0x1F	SC_OUT_1	0x00	byte_1						
0x1E	SC_OUT_0	0x00	byte_0						
0x1D	INT_STATUS_1	0x00	acc_drdy_int	gyr_drdy_int	aux_drdy_int	reserved		err_int	fwm_int	ffull_int
0x1C	INT_STATUS_0	0x00	orientation_out	any_motion_out	no_motion_out	flat_out	tap_out	high_low_g_out	step_counter_out	sig_motion_out
0x1B	EVENT	0x01	reserved			error_code			reserved	por_detected
0x1A	SENSORTIME_2	0x00	sensor_time_23_16						
0x19	SENSORTIME_1	0x00	sensor_time_15_8						
0x18	SENSORTIME_0	0x00	sensor_time_7_0						
0x17	DATA_19	0x00	gyr_z_15_8						
0x16	DATA_18	0x00	gyr_z_7_0						
0x15	DATA_17	0x00	gyr_y_15_8						
0x14	DATA_16	0x00	gyr_y_7_0						
0x13	DATA_15	0x00	gyr_x_15_8						
0x12	DATA_14	0x00	gyr_x_7_0						
0x11	DATA_13	0x00	acc_z_15_8						
0x10	DATA_12	0x00	acc_z_7_0						
0x0F	DATA_11	0x00	acc_y_15_8						

0x0E	DATA_10	0x00	acc_y_7_0					
0x0D	DATA_9	0x00	acc_x_15_8					
0x0C	DATA_8	0x00	acc_x_7_0					
0x0B	DATA_7	0x00	aux_r_15_8					
0x0A	DATA_6	0x00	aux_r_7_0					
0x09	DATA_5	0x00	aux_z_15_8					
0x08	DATA_4	0x00	aux_z_7_0					
0x07	DATA_3	0x00	aux_y_15_8					
0x06	DATA_2	0x00	aux_y_7_0					
0x05	DATA_1	0x00	aux_x_15_8					
0x04	DATA_0	0x00	aux_x_7_0					
0x03	STATUS	0x10	drdy_acc	drdy_gyr	drdy_aux	cmd_rdy	reserved	aux_busy	reserved
0x02	ERR_REG	0x00	aux_err	fifo_err	reserved	internal_err			fatal_err
0x01	-	-	reserved						
0x00	CHIP_ID	0x24	chip_id						

FEATURES Pages

Register Address	Register Name	Page 0	Page 1	Page 2	Page 3
0x30	FEATURES[0,1]	SC_OUT_0_1	Reserved	ORIENT_1	FLAT_1
0x32	FEATURES[2,3]	SC_OUT_2_3	G_TRIG_1	ORIENT_2	FLAT_2
0x34	FEATURES[4,5]	ACT_OUT	GEN_SET_1	HI_G_1	SIGMO_1
0x36	FEATURES[6,7]	ORIENT_HI_G_OUT	ANYMO_1	HI_G_2	Reserved
0x38	FEATURES[8,9]	GYR_GAIN_STATUS	ANYMO_2	HI_G_3	Reserved
0x3A	FEATURES[10,11]	Reserved	NOMO_1	LO_G_1	Reserved
0x3C	FEATURES[12,13]	GYR_CAS	NOMO_2	LO_G_2	Reserved
0x3E	FEATURES[14,15]	Reserved	Reserved	LO_G_3	SIGMO_2

FEATURES Pages

Register Address	Register Name	Page 4	Page 5	Page 6	Page 7
0x30	FEATURES[0,1]	SC_1	TAP_1	TAP_5	Reserved
0x32	FEATURES[2,3]	SC_2	Reserved	Reserved	Reserved
0x34	FEATURES[4,5]	GYR_GAIN_UPD_1	TAP_2	TAP_6	Reserved
0x36	FEATURES[6,7]	GYR_GAIN_UPD_2	TAP_3	Reserved	Reserved
0x38	FEATURES[8,9]	GYR_GAIN_UPD_3	Reserved	Reserved	Reserved
0x3A	FEATURES[10,11]	Reserved	Reserved	Reserved	Reserved
0x3C	FEATURES[12,13]	Reserved	Reserved	Reserved	Reserved
0x3E	FEATURES[14,15]	Reserved	TAP_4	Reserved	Reserved

1 Register (0x00) CHIP_ID

DESCRIPTION: Chip identification code
RESET: 0x24
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x00		CHIP_ID		0x24	
	7...0	chip_id	Chip identification code	0x24	R

2 Register (0x02) ERR_REG

DESCRIPTION: Reports sensor error conditions
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x02		ERR_REG		0x00	
	0	fatal_err	Fatal Error, chip is not in operational state (Boot-, power-system). This flag will be reset only by power-on-reset or softreset.	0x0	R
	4...1	internal_err	Internal error, please contact your Bosch Sensortec regional support team.	0x0	R
	6	fifo_err	Error when a frame is read in streaming mode (so skipping is not possible) and fifo is overfilled (with virtual and/or regular frames). This flag will be reset when read.	0x0	R
	7	aux_err	Error in I2C-Master detected. This flag will be reset when read.	0x0	R

3 Register (0x03) STATUS

DESCRIPTION: Sensor status flags
RESET: 0x10
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x03		STATUS		0x10	
	2	aux_busy	'1'('0') indicate a (no) Auxiliary sensor interface operation is ongoing triggered via AUX_RD_ADDR, AUX_WR_ADDR or from FCU.	0x0	R
	4	cmd_rdy	CMD decoder status. `0´ -> Command in progress `1´ -> Command decoder is ready to accept a new command	0x1	R
	5	drdy_aux	Data ready for Auxiliary sensor. It gets reset, when one Auxiliary sensor DATA register is read out	0x0	R
	6	drdy_gyr	Data ready for Gyroscope. It gets reset, when one Gyroscope DATA register is read out	0x0	R
	7	drdy_acc	Data ready for Accelerometer. It gets reset, when one Accelerometer DATA register is read out	0x0	R

4 Register (0x04) DATA_0

DESCRIPTION: AUX_X(LSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x04		DATA_0		0x00	
	7...0	aux_x_7_0	copy of register Val(AUX_IF[1]) in Auxiliary sensor register map.	0x0	R

5 Register (0x05) DATA_1

DESCRIPTION: AUX_X(MSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x05		DATA_1		0x00	
	7...0	aux_x_15_8	copy of register Val(AUX_IF[1])+1 in Auxiliary sensor register map	0x0	R

6 Register (0x06) DATA_2

DESCRIPTION: AUX_Y(LSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x06		DATA_2		0x00	
	7...0	aux_y_7_0	copy of register Val(AUX_IF[1])+2 in Auxiliary sensor register map	0x0	R

7 Register (0x07) DATA_3

DESCRIPTION: AUX_Y(MSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x07		DATA_3		0x00	
	7...0	aux_y_15_8	copy of register Val(AUX_IF[1])+3 in Auxiliary sensor register map	0x0	R

8 Register (0x08) DATA_4

DESCRIPTION: AUX_Z(LSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x08		DATA_4		0x00	
	7...0	aux_z_7_0	copy of register Val(AUX_IF[1])+4 in Auxiliary sensor register map	0x0	R

9 Register (0x09) DATA_5

DESCRIPTION: AUX_Z(MSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x09		DATA_5		0x00	
	7...0	aux_z_15_8	copy of register Val(AUX_IF[1])+5 in Auxiliary sensor register map	0x0	R

10 Register (0x0A) DATA_6

DESCRIPTION: AUX_R(LSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x0A		DATA_6		0x00	
	7...0	aux_r_7_0	copy of register Val(AUX_IF[1])+6 in Auxiliary sensor register map	0x0	R

11 Register (0x0B) DATA_7

DESCRIPTION: AUX_R(MSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x0B		DATA_7		0x00	
	7...0	aux_r_15_8	copy of register Val(AUX_IF[1])+7 in Auxiliary sensor register map	0x0	R

12 Register (0x0C) DATA_8

DESCRIPTION: ACC_X(LSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x0C		DATA_8		0x00	
	7...0	acc_x_7_0		0x0	R

13 Register (0x0D) DATA_9

DESCRIPTION: ACC_X(MSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x0D		DATA_9		0x00	
	7...0	acc_x_15_8		0x0	R

14 Register (0x0E) DATA_10

DESCRIPTION: ACC_Y(LSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x0E		DATA_10		0x00	
	7...0	acc_y_7_0		0x0	R

15 Register (0x0F) DATA_11

DESCRIPTION: ACC_Y(MSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x0F		DATA_11		0x00	
	7...0	acc_y_15_8		0x0	R

16 Register (0x10) DATA_12

DESCRIPTION: ACC_Z(LSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x10		DATA_12		0x00	
	7...0	acc_z_7_0		0x0	R

17 Register (0x11) DATA_13

DESCRIPTION: ACC_Z(MSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x11		DATA_13		0x00	
	7...0	acc_z_15_8		0x0	R

18 Register (0x12) DATA_14

DESCRIPTION: GYR_X(LSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x12		DATA_14		0x00	
	7...0	gyr_x_7_0		0x0	R

19 Register (0x13) DATA_15

DESCRIPTION: GYR_X(MSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x13		DATA_15		0x00	
	7...0	gyr_x_15_8		0x0	R

20 Register (0x14) DATA_16

DESCRIPTION: GYR_Y(LSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x14		DATA_16		0x00	
	7...0	gyr_y_7_0		0x0	R

21 Register (0x15) DATA_17

DESCRIPTION: GYR_Y(MSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x15		DATA_17		0x00	
	7...0	gyr_y_15_8		0x0	R

22 Register (0x16) DATA_18

DESCRIPTION: GYR_Z(LSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x16		DATA_18		0x00	
	7...0	gyr_z_7_0		0x0	R

23 Register (0x17) DATA_19

DESCRIPTION: GYR_Z(MSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x17		DATA_19		0x00	
	7...0	gyr_z_15_8		0x0	R

24 Register (0x18) SENSORTIME_0

DESCRIPTION: Sensor time <7:0>
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x18		SENSORTIME_0		0x00	
	7...0	sensor_time_7_0	Sensor time <7:0>	0x0	R

25 Register (0x19) SENSORTIME_1

DESCRIPTION: Sensor time <15:8>
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x19		SENSORTIME_1		0x00	
	7...0	sensor_time_15_8	Sensor time <15:8>.	0x0	R

26 Register (0x1A) SENSORTIME_2

DESCRIPTION: Sensor time <23:16>
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x1A		SENSORTIME_2		0x00	
	7...0	sensor_time_23_16	Sensor time <23:16> The sensor time is a 24 bit counter available in suspend, low power, and normal mode. The value of the SENSORTIME register is shadowed, when it is read in a burst read with the data register at the beginning of the operation and the shadowed value is returned. When the fifo is read the register is shadowed, whenever a new frame is read. The resolution of the sensor_time is 39.0625 us, and it is synchrounous to ODR. The register wraps if it reaches 0xFFFFFF.	0x0	R

27 Register (0x1B) EVENT

DESCRIPTION: Sensor event flags. Will be cleared on read when bit 0 is sent out over the bus.
RESET: 0x01
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x1B		EVENT		0x01	
	0	por_detected	'1' after device power up or softreset, '0' after status read.	0x1	R
	4...2	error_code	Error codes for persistent errors **Value** **Name** **Description** 0x00 no_error no error is reported 0x01 acc_err error in Register ACC_CONF 0x02 gyr_err error in Register GYR_CONF 0x03 acc_and_gyr_err error in Registers ACC_GYR & GYR_CONF	0x0	R

28 Register (0x1C) INT_STATUS_0

DESCRIPTION: Interrupt/Feature Status. Will be cleared on read.
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x1C		INT_STATUS_0		0x00	
	0	sig_motion_out	Sigmotion output.	0x0	R
	1	step_counter_out	Step-counter watermark or Step-detector output or Step activity output	0x0	R
	2	high_low_g_out	High-g and Low-g detection output	0x0	R
	3	tap_out	Tap output	0x0	R
	4	flat_out	Flat output	0x0	R
	5	no_motion_out	No motion detection output	0x0	R
	6	any_motion_out	Any motion detection output	0x0	R
	7	orientation_out	Orientation output	0x0	R

29 Register (0x1D) INT_STATUS_1

DESCRIPTION: Interrupt Status 1. Will be cleared on read when bit 0 is sent out over the bus.
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x1D		INT_STATUS_1		0x00	
	0	ffull_int	FIFO Full Interrupt	0x0	R
	1	fwm_int	FIFO Watermark Interrupt	0x0	R
	2	err_int	ERROR Interrupt	0x0	R
	5	aux_drdy_int	Auxiliary Data Ready Interrupt	0x0	R
	6	gyr_drdy_int	Gyroscope Data Ready Interrupt	0x0	R
	7	acc_drdy_int	Accelerometer Data Ready Interrupt	0x0	R

30 Register (0x1E) SC_OUT_0

DESCRIPTION: Step counting value byte-0
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x1E		SC_OUT_0		0x00	
	7...0	byte_0	Step counting value byte-0 (least significant byte)	0x0	R

31 Register (0x1F) SC_OUT_1

DESCRIPTION: Step counting value byte-1
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x1F		SC_OUT_1		0x00	
	7...0	byte_1	Step counting value byte-1	0x0	R

32 Register (0x20) ORIENT_ACT

DESCRIPTION: Orientation and activity detection output
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x20		ORIENT_ACT		0x00	
	1...0	portrait_landscape	Output value of the orientation detection feature. Value after device initialization is 0b00 i.e. Portrait upright **Value** / **Name** / **Description** 0x00 / portrait_upright / Portrait upright orientation 0x01 / landscape_left / Landscape left orientation 0x02 / portrait_upside_down / Portrait upside down orientation 0x03 / landscape_right / Landscape right orientation	0x0	R
	2	faceup_down	Output value of face down face up orientation (only if ud_en is enabled). Value after device initialization is 0b0 i.e. Face up **Value** / **Name** / **Description** 0x00 / face_up / Face up orientation 0x01 / face_down / Face down orientation	0x0	R
	4...3	act_out	Output value of the activity detection feature. Value after device initialization is 0b11 i.e. unknown activity **Value** / **Name** / **Description** 0x00 / still / User stationary	0x0	R

			0x01 walking User walking 0x02 running User running 0x03 unknown Unknown state		
	5	s_tap_out	Single tap detected	0x0	R
	6	d_tap_out	Double tap detected	0x0	R
	7	t_tap_out	Triple tap detected	0x0	R

33 Register (0x21) INTERNAL_STATUS

DESCRIPTION: Error bits and message indicating internal status
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x21		INTERNAL_STATUS		0x00	
	3...0	message	Internal Status Message **Value** **Name** **Description** 0x00 not_init ASIC is not initialized 0x01 init_ok ASIC initialized 0x02 init_err Initialization error 0x03 drv_err Invalid driver 0x04 sns_stop Sensor stopped 0x05 nvm_error Internal error while accessing NVM 0x06 start_up_error Internal error while accessing NVM and Initialization error 0x07 compat_error Compatibility error	0x0	R
	4	Reserved	Reserved	0x0	R
	5	axes_remap_error	Incorrect axes remapping. X,Y,Z axes must be mapped to exclusively separate axes i.e. they cannot be mapped to same axes.	0x0	R

	6	odr_50hz_error	The minimum bandwidth conditions are not respected for the features which require 50 Hz data.	0x0	R
	7	odr_high_error	The minimum bandwidth conditions are not respected for the features which require 200 Hz data.	0x0	R

34 Register (0x22) TEMPERATURE_0

DESCRIPTION: Temperature LSB; The temperature is disabled when all sensors are in suspend. The output word of the 16-bit temperature sensor is valid if the Gyroscope is in normal mode, i.e. gyr_pmu_status=1. The resolution is 1/2^9 K/LSB. The absolute accuracy of the temperature is in the order of:

0x7FFF -> 87-1/2^9 °C
0x0000 -> 23°C
0x8001 -> -41+1/2^9 °C
0x8000 -> invalid

If the Gyroscope is in normal mode (see register PMU_STATUS), the temperature is updated every 10 ms (+-12%), if the gyroscope is in standby mode or fast-power up mode, the temperature is updated ever 1.28 s aligned with bit 15 of the register SENSORTIME.
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x22		TEMPERATURE_0		0x00	
	7...0	tmp_data_7_0	Temperature value.	0x0	R

35 Register (0x23) TEMPERATURE_1

DESCRIPTION: Contains the MSBs of temperature sensor value
RESET: 0x80
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x23		TEMPERATURE_1		0x80	
	7...0	tmp_data_15_8	Temperature LSBs.	0x80	R

36 Register (0x24) FIFO_LENGTH_0

DESCRIPTION: FIFO byte count register (LSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x24		FIFO_LENGTH_0		0x00	
	7...0	fifo_byte_counter_7_0	Current fill level of FIFO buffer This includes the skip frame for a full fifo. An empty FIFO corresponds to 0x000. The byte counter may be reset by reading out all frames from the FIFO buffer or when the FIFO is reset through the register CMD. The byte counter is updated each time a complete frame was read or written.	0x0	R

37 Register (0x25) FIFO_LENGTH_1

DESCRIPTION: FIFO byte count register (MSB)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x25		FIFO_LENGTH_1		0x00	
	5...0	fifo_byte_counter_13_8	FIFO byte counter bits 13..8	0x0	R

38 Register (0x26) FIFO_DATA

DESCRIPTION: FIFO data output register
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x26		FIFO_DATA		0x00	
	7...0	fifo_data	FIFO read data,for burst read (8 bits). Data format depends on the setting of register FIFO_CONFIG. The FIFO data are organized in frames. The new data flag is preserved. Read burst access must be used, the address will not increment when the read burst reads at the address of FIFO_DATA. When a frame is only partially read out it is retransmitted including the header at the next readout.	0x0	R

39 Register (0x2F) FEAT_PAGE

DESCRIPTION: Page number for feature configuration and output registers
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x2F		FEAT_PAGE		0x00	
	2...0	page	Map 16 feature registers to one of the 8 feature pages	0x0	RW

40 Register (0x30) FEATURES[16]

DESCRIPTION: Input registers for feature configuration. Output registers for feature results.
RESET: 0x00
DEFINITION (Go to register map):

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Address	Bit	Name	Description	Reset	Access
step_counter_output					
0x30		SC_OUT_0_1	Describes lower word of step counter	0x0000	
	7...0	byte_0	Value of step counter byte 0	0x0	R
	15...8	byte_1	Value of step counter byte 1	0x0	R
0x32		SC_OUT_2_3	Describes higher word of step counter	0x0000	
	7...0	byte_2	Value of step counter byte 2	0x0	R
	15...8	byte_3	Value of step counter byte 3	0x0	R
activity_output					
0x34		ACT_OUT	Describes activity output	0x0000	
	1...0	act_out	Output value of the activity detection feature. Value after device initialization is 0b11 i.e. unknown activity **Value** **Name** **Description** 0x00 still User stationary 0x01 walking User walking 0x02 running User running 0x03 unknown Unknown state	0x0	R
orientation_and_high_g_output					
0x36		ORIENT_HI_G_OUT	Describes orientation and high_g output	0x0000	

	1...0	portrait_landscape	Output value of the orientation detection feature. Value after device initialization is 0b00 i.e. portrait upright **Value** / **Name** / **Description** 0x00 / portrait_upright / Portrait upright orientation 0x01 / landscape_left / Landscape left orientation 0x02 / portrait_upside_down / Portrait upside down orientation 0x03 / landscape_right / Landscape right orientation	0x0	R
	2	faceup_down	Output value of face down face up orientation (only if ud_en is enabled). Value after device initialization is 0b0 i.e. face up **Value** / **Name** / **Description** 0x00 / face_up / Face up orientation 0x01 / face_down / Face down orientation	0x0	R
	3	high_g_detect_x	High-g was detected on X-axis	0x0	R
	4	high_g_detect_y	High-g was detected on Y-axis	0x0	R
	5	high_g_detect_z	High-g was detected on Z-axis	0x0	R
	6	high_g_detect_sign	Axis direction for which the high-g was detected. 1 for negative axis, 0 for positive axis.	0x0	R
gyr_gain_status					
0x38		GYR_GAIN_STATUS	Describes the saturation status for the gyroscope gain update and G_TRIGGER command status	0x0000	
	0	sat_x	This bit will be 1 if the updated gain results to saturated value based on the ratio provided for x axis, otherwise it will be 0	0x0	R
	1	sat_y	This bit will be 1 if the updated gain results to saturated value based on the ratio provided for y axis, otherwise it will be 0	0x0	R
	2	sat_z	This bit will be 1 if the updated gain results to saturated value based on the ratio provided for z axis, otherwise it will be 0	0x0	R

	5...3	g_trig_status	Status of gyroscope trigger G_TRIGGER command. These bits are updated at the end of feature execution. **Value** **Name** **Description** 0x00 no_err Command is valid. Selected feature has been executed and output of feature has been updated. 0x01 precon_err Command is aborted. Pre-condition to start the feature was not completed. 0x02 dl_err Command is aborted. Unsuccessful download of 2kB configuration stream. 0x03 abort_err Command is aborted either by host via the block bit or due to motion detection.	0x0	R
Reserved					
0x3A		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	R
gyr_postproc					
0x3C		GYR_CAS	Register for gyroscope data post processing	0x0000	
	6...0	factor_zx	Factor to further optimize the gyroscope performance	0x0	R
Reserved					
0x3E		Reserved	Reserved	0x0000	
	8	Reserved	Reserved	0x0	R
	9	Reserved	Reserved	0x0	R
	10	Reserved	Reserved	0x0	R
	11	Reserved	Reserved	0x0	R
	12	Reserved	Reserved	0x0	R
	13	Reserved	Reserved	0x0	R

	14	Reserved	Reserved	0x0	R
	15	Reserved	Reserved	0x0	R

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Address	Bit	Name	Description	Reset	Access
general_settings					
0x30		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	R
0x32		G_TRIG_1	Configuration for features triggered by G_TRIGGER command.	0x0000	
	7...0	max_burst_len	Maximum burst-write length in 16-bits words to download 2kB configuration stream of G_TRIGGER feature. Range is 0 to 255. E.g. value = 20 means that maximum burst-write length is set to 20 words or 40 bytes.	0x0	RW
	8	select	Select feature that should be executed **Value** **Name** **Description** 0x00 gyr_bist Gyroscope built-in self-test will be executed 0x01 crt CRT will be executed	0x0	RW
	9	block	Block feature with next G_TRIGGER command **Value** **Name** **Description** 0x00 unblock Do not block further G_TRIGGER commands 0x01 block With the next G_TRIGGER command, the ongoing selected feature will be aborted OR if a feature is not ongoing then the G_TRIGGER command will be ignored	0x0	RW
0x34		GEN_SET_1	Describes configuration of general features	0x0088	
	1...0	map_x_axis	Map the x axis to desired axis	0x0	RW

			Value **Name** **Description** 0x00 x_axis Map to x-axis 0x01 y_axis Map to y-axis 0x02 z_axis Map to z-axis 0x03 reserved Map to x-axis		
	2	map_x_axis_sign	Map the x axis sign to the desired one. **Value** **Name** **Description** 0x00 not_invert Clear this bit to not invert the x axis 0x01 invert Set this bit to invert the x axis	0x0	RW
	4...3	map_y_axis	Map the y axis to desired axis **Value** **Name** **Description** 0x00 x_axis Map to x-axis 0x01 y_axis Map to y-axis 0x02 z_axis Map to z-axis 0x03 reserved Map to y-axis	0x1	RW
	5	map_y_axis_sign	Map the y axis sign to the desired one **Value** **Name** **Description** 0x00 not_invert Clear this bit to not invert the y axis 0x01 invert Set this bit to invert the y axis	0x0	RW
	7...6	map_z_axis	Map the z axis to desired axis **Value** **Name** **Description** 0x00 x_axis Map to x-axis 0x01 y_axis Map to y-axis 0x02 z_axis Map to z-axis 0x03 reserved Map to z-axis	0x2	RW
	8	map_z_axis_sign	Map the z axis sign to the desired one **Value** **Name** **Description** 0x00 not_invert Clear this bit to not invert the z axis 0x01 invert Set this bit to invert the z axis	0x0	RW
	9	gyr_self_off	Describes the self offset correction behavior **Value** **Name** **Description** 0x00 disable Disable self offset correction. Host should update	0x0	RW

			0x01 enable	Enable self offset correction. Gyroscope offset register will be updated by the device. Host should not update the gyroscope offset registers.		
	10	nvm_prog_prep	Prepares the system for NVM programming	0x0	RW
any_motion					
0x36		ANYMO_1	Any-motion detection general configuration flags - part 1	0xE005	
	12...0	duration	Defines the number of consecutive data points for which the threshold condition must be respected, for interrupt assertion. It is expressed in 50 Hz samples (20 ms). Range is 0 to 163sec. Default value is 5=100ms.	0x5	RW
	13	select_x	Selects the feature on a per-axis basis	0x1	RW
	14	select_y	Selects the feature on a per-axis basis	0x1	RW
	15	select_z	Selects the feature on a per-axis basis	0x1	RW
0x38		ANYMO_2	Any-motion detection general configuration flags - part 2	0x38AA	
	10...0	threshold	Slope threshold value for any-motion detection. Range is 0 to 1g. Default value is 0xAA = 83mg.	0xAA	RW
	14...11	Reserved	Reserved	0x7	R
	15	enable	Enables the feature	0x0	RW
no_motion					
0x3A		NOMO_1	No-motion detection general configuration flags - part 1	0xE005	
	12...0	duration	Defines the number of consecutive data points for which the threshold condition must be respected, for interrupt assertion.	0x5	RW

			It is expressed in 50 Hz samples (20 ms). Range is 0 to 163sec. Default value is 5=100ms.		
	13	select_x	Selects the feature on a per-axis basis	0x1	RW
	14	select_y	Selects the feature on a per-axis basis	0x1	RW
	15	select_z	Selects the feature on a per-axis basis	0x1	RW
0x3C		NOMO_2	No-motion detection general configuration flags - part 2	0x3090	
	10...0	threshold	Slope threshold value for no-motion detection. Range is 0 to 1g. Default value is 0x90 = 70mg.	0x90	RW
	14...11	Reserved	Reserved	0x6	R
	15	enable	Enables the feature	0x0	RW
Reserved					
0x3E		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW

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Address	Bit	Name	Description	Reset	Access
Orientation					
0x30		ORIENT_1	Orientation general configuration flags	0x0A30	
	0	enable	Enables the feature	0x0	RW
	1	ud_en	Enables upside/down detection, if set to 1	0x0	RW
	3...2	mode	Sets the mode: symmetrical (values 0 or 3), high asymmetrical (value 1) or low asymmetrical (value 2).	0x0	RW
	5...4	blocking	Sets the blocking mode. If blocking is set, no Orientation interrupt will be triggered. Default value is 3 – the most restrictive blocking mode.	0x3	RW
	11...6	theta	Coded value of the threshold angle with horizontal used in Blocking modes; theta = 64 * (tan(angle)^2); default value is 40, equivalent to 38 degrees angle.	0x28	RW
0x32		ORIENT_2	Acceleration hysteresis	0x4080	
	10...0	hysteresis	Acceleration hysteresis for orientation detection. Default value is 128 = 0.0625g. Range is 0 to 1g.	0x80	RW

	14...11	Reserved	Reserved	0x8	R
high_g					
0x34		HI_G_1	The acceleration threshold above which the high_g motion is signaled.	0x2710	
	14...0	threshold	Threshold value for high_g feature. Range is 0 to 16g. Default value is 10000 = 4.9g.	0x2710	RW
0x36		HI_G_2	Enable flags and hysteresis configuration	0x73E8	
	11...0	hysteresis	Hysteresis value for high_g feature. Range is 0 to 2g. Default value is 1000 = 0.49g.	0x3E8	RW
	12	select_x	Selects the feature on a per-axis basis	0x1	RW
	13	select_y	Selects the feature on a per-axis basis	0x1	RW
	14	select_z	Selects the feature on a per-axis basis	0x1	RW
	15	enable	Enables the feature	0x0	RW
0x38		HI_G_3	Output configuration and duration interval	0x3004	
	11...0	duration	Duration in 200 Hz samples (5 msec) for which the threshold has to be exceeded. Range is 0 to 20 sec. Default value is 4 = 20 msec.	0x4	RW
	15...12	Reserved	Reserved	0x3	R
low_g					
0x3A		LO_G_1	The acceleration threshold below which the low_g motion is signaled.	0x0200	
	14...0	threshold	Threshold value for low-g feature. Range is 0 to 1g. Default value is 512 = 0.25g.	0x200	RW
0x3C		LO_G_2	Enable flag and hysteresis configuration	0x0100	
	11...0	hysteresis	Hysteresis value for low_g feature. Range is 0 to 0.5g. Default value is 256 = 0.125g.	0x100	RW
	12	enable	Enables the feature	0x0	RW
0x3E		LO_G_3	Output configuration and duration interval	0x3000	
	11...0	duration	Duration in 50 Hz samples (20 msec) for which the threshold has to be exceeded. Range is 0 to 82 sec. Default value is 0 = 0 ms.	0x0	RW
	15...12	Reserved	Reserved	0x3	R

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Address	Bit	Name	Description	Reset	Access
flat					
0x30		FLAT_1	Flat detection enable, output and theta angle configuration	0x0B10	
	0	enable	Enables the feature	0x0	RW
	6...1	theta	Sets the theta angle, used for detecting flat position. Theta = 64 * (tan(angle)^2); default value is 8, equivalent to 20 degrees angle.	0x8	RW
	8...7	blocking	Sets the blocking mode. If blocking is set, no Flat interrupt will be triggered. Default value is 2 – the most restrictive blocking mode.	0x2	RW
	12...9	Reserved	Reserved	0x5	R
0x32		FLAT_2	Hysteresis and hold time	0x0809	
	5...0	hysteresis	Hysteresis for Theta Flat detection. The coding is presented in the Flat Description section. Default value is 9 = 2.5 degrees, corresponding to the default Theta angle of 20 degrees.	0x9	RW
	13...6	hold_time	Holds the duration (expressed in 50Hz samples number) for which the condition has to be respected; default value is 32 = 640 msec. Range is 0 to 5.1 sec.	0x20	RW
sig_motion					
0x34		SIGMO_1	Block size	0x00FA	
	15...0	block_size	Defines the duration after which the significant motion interrupt is triggered. It is expressed in 50 Hz samples (20 ms). Default value is 0xFA=5sec.	0xFA	RW
0x36		Reserved	Reserved	0x0096	
	15...0	Reserved	Reserved	0x96	RW
0x38		Reserved	Reserved	0x094B	
	15...0	Reserved	Reserved	0x94B	RW
0x3A		Reserved	Reserved	0x0011	
	15...0	Reserved	Reserved	0x11	RW
0x3C		Reserved	Reserved	0x0011	
	15...0	Reserved	Reserved	0x11	RW
0x3E		SIGMO_2	Significant motion setting	0x0002	
	0	enable	Enables the feature	0x0	RW
	4...1	Reserved	Reserved	0x1	R

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Address	Bit	Name	Description	Reset	Access
step_counter					
0x30		SC_1	Step counter and step detector settings	0x0000	
	9...0	watermark_level	Watermark level; the Step-counter will trigger output every time this number of steps are counted. Holds implicitly a 20x factor, so the range is 0 to 20460, with resolution of 20 steps. If 0, the output is disabled.	0x0	RW
	10	reset_counter	Step count value can be reset only when any one of features mentioned in this register is enabled.	0x0	RW
	11	en_detector	Enables the Step Detector.	0x0	RW
	12	en_counter	Enables the Step Counter.	0x0	RW
	13	en_activity	Enables the activity detection(Running, Walking, Stationary, Unknown)	0x0	RW
0x32		SC_2	Step counter and step detector settings	0x0722	
	3...0	Reserved	Reserved	0x2	R
	7...4	Reserved	Reserved	0x2	R
	15...8	step_buffer_size	Step counter buffer size	0x7	RW
gyr_gain_update					
0x34		GYR_GAIN_UPD_1	ωrx/ωmx for which the gain needs to be updated.	0x0000	
	10...0	ratio_x	gain update value for x-axis. Fixed point representation is Q(1,10) with range from 1±0.25. For example, value of 0.75 shall be represented in 11bits as 0x300 and 1.25 shall be represented in 11bits as 0x500	0x0	RW
0x36		GYR_GAIN_UPD_2	ωry/ωmy for which the gain needs to be updated.	0x0000	
	10...0	ratio_y	gain update value for y-axis. Fixed point representation is Q(1,10) with range from 1±0.25. For example, value of 0.75 shall be represented in 11bits as 0x300 and 1.25 shall be represented in 11bits as 0x500	0x0	RW
0x38		GYR_GAIN_UPD_3	ωrz/ωmz for which the gain needs to be updated.	0x0000	

	10...0	ratio_z	gain update value for z-axis. Fixed point representation is Q(1,10) with range from 1±0.25. For example, value of 0.75 shall be represented in 11bits as 0x300 and 1.25 shall be represented in 11bits as 0x500	0x0	RW
	11	enable	Enable the gyroscope gain update by writing a value 1 to it. Once the gain update is completed, the device will clear the bit.	0x0	RW
Reserved					
0x3A		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW
0x3C		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW
0x3E		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW

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Address	Bit	Name	Description	Reset	Access
tap					
0x30		TAP_1	Tap detector general configuration flags	0x0040	
	0	single_tap_en	Single tap detection is enabled	0x0	RW
	1	double_tap_en	Double tap detection is enabled	0x0	RW
	2	triple_tap_en	Triple tap detection is enabled	0x0	RW
	3	data_reg_en	By enabling this bit, accel data according to the user defined accel configuration is taken for tap detector feature (ODR must be set to 200Hz for the use of tap detector feature). When this bit is disabled, 200Hz unfiltered accel data is used for tap detector feature.	0x0	RW
	7...4	Reserved	Reserved	0x4	R
	15...8	reserved	Reserved	0x0	RW
0x32		Reserved	Configurations for tap detector - Part 1	0x0006	
	15...0	Reserved	Reserved	0x6	RW
0x34		TAP_2	Configurations for tap detector - Part 2	0x0009	
	15...0	tap_sens_thres	Configures detection sensitivity by a Scaling factor of additional threshold increment for detection of	0x9	RW

			positive and negative peak of a tap. Default value = 9, Recommended range = 0 to 15. Resolution of each LSB of scaling factor in terms of filtered acceleration signal magnitude is 78.125 mg.		
0x36		TAP_3	Configurations for tap detector - Part 3	0x0082	
	15...0	max_gest_dur	Maximum duration after the first tap within which the second and/or third tap have to be performed for being detected as double-tap or triple-tap. Default value = 130 (650 ms), Resolution = 5 ms, Recommended range = 250 to 1000 ms.	0x82	RW
0x38		Reserved	Configurations for tap detector - Part 4	0x0006	
	15...0	Reserved	Reserved	0x6	RW
0x3A		Reserved	Configurations for tap detector - Part 5	0x0006	
	15...0	Reserved	Reserved	0x6	RW
0x3C		Reserved	Configurations for tap detector - Part 6	0x0008	
	15...0	Reserved	Reserved	0x8	RW
0x3E		TAP_4	Configurations for tap detector - Part 7	0x0050	
	15...0	quite_time_after_gest	Minimum quite time between the two gesture detection. Default value = 80 (400 ms), Resolution = 5 ms, Recommended range = 250 to 500 ms.	0x50	RW

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Address	Bit	Name	Description	Reset	Access
tap					
0x30		TAP_5	Configurations for tap detector - Part 8	0x0000	
	15...0	wait_for_timeout	By enabling, the feature will wait for max_gest_duration before reporting the detected tap-gesture. By disabling, the feature will report the tap-gesture immediately after it has been detected. This can lead to multiple reports of detected tap-gestures within max_gest_duration. Default value = 0 (disabled). Allowed values = 0 / 1 (disabled / enabled)	0x0	RW
0x32		Reserved	Configurations for tap detector - Part 9	0x044C	
	15...0	Reserved	Reserved	0x44C	RW
0x34		TAP_6	Configurations for tap detector - Part 10	0x0002	
	1...0	axis_sel	Selection of axis from 3D-acceleration signal vector for tap detection. Default value = 2 (z-axis). Other supported values 0 (x-axis) and 1 (y-axis). Any other selection leads to usage of default value **Value** **Name** **Description** 0x00 x-axis Use x-axis for tap detection 0x01 y-axis Use y-axis for tap detection 0x02 z-axis Use z-axis for tap detection 0x03 reserved Use z-axis for tap detection	0x2	RW
	15...2	Reserved	Reserved	0x0	RW
0x36		Reserved	Configurations for tap detector - Part 11	0x0003	
	15...0	Reserved	Reserved	0x3	RW
0x38		Reserved	Configurations for tap detector - Part 12	0x0000	
	15...0	Reserved	Reserved	0x0	RW
Reserved					
0x3A		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW
0x3C		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW
0x3E		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW

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Address	Bit	Name	Description	Reset	Access
Reserved					
0x30		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW
0x32		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW
0x34		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW
0x36		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW
0x38		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW
0x3A		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW
0x3C		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW
0x3E		Reserved	Reserved	0x0000	
	15...0	Reserved	Reserved	0x0	RW

41 Register (0x40) ACC_CONF

DESCRIPTION: Sets the output data rate, the bandwidth, and the read mode of the acceleration sensor
RESET: 0xA8
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x40		ACC_CONF		0xA8	
	3...0	acc_odr	ODR in Hz. The output data rate is independent of the power mode setting for the sensor **Value** **Name** **Description** 0x00 reserved Reserved 0x01 odr_0p78 25/32 0x02 odr_1p5 25/16 0x03 odr_3p1 25/8 0x04 odr_6p25 25/4 0x05 odr_12p5 25/2 0x06 odr_25 25 0x07 odr_50 50 0x08 odr_100 100 0x09 odr_200 200 0x0a odr_400 400 0x0b odr_800 800 0x0c odr_1k6 1600 0x0d odr_3k2 Reserved 0x0e odr_6k4 Reserved 0x0f odr_12k8 Reserved	0x8	RW
	6...4	acc_bwp	Bandwidth parameter determines filter configuration (acc_filt_perf=1) and averaging for undersampling mode (acc_filt_perf=0) **Value** **Name** **Description** 0x00 osr4_avg1 acc_filt_perf = 1 -> OSR4 mode; acc_filt_perf = 0 -> no averaging 0x01 osr2_avg2 acc_filt_perf = 1 -> OSR2 mode; acc_filt_perf = 0 -> average 2 samples 0x02 norm_avg4 acc_filt_perf = 1 -> normal mode; acc_filt_perf = 0 -> average 4 samples 0x03 cic_avg8 acc_filt_perf = 1 -> CIC mode; acc_filt_perf = 0 -> average 8 samples 0x04 res_avg16 acc_filt_perf = 1 -> Reserved;	0x2	RW

			0x05 0x06 0x07	res_avg32 res_avg64 res_avg128	acc_filt_perf = 0 -> average 16 samples acc_filt_perf = 1 -> Reserved; acc_filt_perf = 0 -> average 32 samples acc_filt_perf = 1 -> Reserved; acc_filt_perf = 0 -> average 64 samples acc_filt_perf = 1 -> Reserved; acc_filt_perf = 0 -> average 128 samples		
	7	acc_filter_perf	Select accelerometer filter performance mode: **Value** **Name** **Description** 0x00 ulp power optimized 0x01 hp performance opt.			0x1	RW

42 Register (0x41) ACC_RANGE

DESCRIPTION: Selection of the Accelerometer g-range
RESET: 0x02
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x41		ACC_RANGE		0x02	
	1...0	acc_range	Accelerometer g-range **Value** **Name** **Description** 0x00 range_2g +/-2g 0x01 range_4g +/-4g 0x02 range_8g +/-8g 0x03 range_16g +/-16g	0x2	RW

43 Register (0x42) GYR_CONF

DESCRIPTION: Sets the output data rate and the bandwidth of the Gyroscope in the sensor
RESET: 0xA9
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x42		GYR_CONF		0xA9	
	3...0	gyr_odr	ODR in Hz **Value Name Description** 0x00 reserved Reserved 0x01 odr_0p78 Reserved 0x02 odr_1p5 Reserved 0x03 odr_3p1 Reserved 0x04 odr_6p25 Reserved 0x05 odr_12p5 Reserved 0x06 odr_25 25 0x07 odr_50 50 0x08 odr_100 100 0x09 odr_200 200 0x0a odr_400 400 0x0b odr_800 800 0x0c odr_1k6 1600 0x0d odr_3k2 3200 0x0e odr_6k4 Reserved 0x0f odr_12k8 Reserved	0x9	RW
	5...4	gyr_bwp	The Gyroscope bandwidth coefficient defines the 3 dB cutoff frequency of the low pass filter for the sensor data **Value Name Description** 0x00 osr4 OSR4 mode 0x01 osr2 OSR2 mode 0x02 norm normal mode 0x03 res reserved	0x2	RW
	6	gyr_noise_perf	Select noise performance: **Value Name Description** 0x00 ulp power optimized 0x01 hp performance opt.	0x0	RW
	7	gyr_filter_perf	Select gyroscope filter performance mode: **Value Name Description** 0x00 ulp power optimized 0x01 hp performance opt.	0x1	RW

44 Register (0x43) GYR_RANGE

DESCRIPTION: Defines the Gyroscope angular rate measurement range
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x43		GYR_RANGE		0x00	
	2...0	gyr_range	Full scale, Resolution: applies to filtered FIFO data and DATA registers. **Value** **Name** **Description** 0x00 range_2000 +/-2000dps, 16.4 LSB/dps 0x01 range_1000 +/-1000dps, 32.8 LSB/dps 0x02 range_500 +/-500dps, 65.6 LSB/dps 0x03 range_250 +/-250dps, 131.2 LSB/dps 0x04 range_125 +/-125dps, 262.4 LSB/dps	0x0	RW
	3	ois_range	Full scale, Resolution: applies to pre-filtered FIFO data and OIS data. **Value** **Name** **Description** 0x00 range_250 +/-250dps, 131.2 LSB/dps 0x01 range_2000 +/-2000dps, 16.4 LSB/dps	0x0	RW

45 Register (0x44) AUX_CONF

DESCRIPTION: Sets the output data rate of the Auxiliary sensor interface
RESET: 0x46
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x44		AUX_CONF		0x46	
	3...0	aux_odr	define the poll rate for the magnetometer attached to the Auxiliary sensor interface. This is independent of the power mode setting for the sensor. The output data rate in Hz. In addition to setting the poll rate, it is required to configure the Auxiliary sensor properly using the AUX_IF_CONF register. **Value Name Description** 0x00 reserved Reserved 0x01 odr_0p78 25/32 0x02 odr_1p5 25/16 0x03 odr_3p1 25/8 0x04 odr_6p25 25/4 0x05 odr_12p5 25/2 0x06 odr_25 25 0x07 odr_50 50 0x08 odr_100 100 0x09 odr_200 200 0x0a odr_400 400 0x0b odr_800 800 0x0c odr_1k6 Reserved 0x0d odr_3k2 Reserved 0x0e odr_6k4 Reserved 0x0f odr_12k8 Reserved	0x6	RW
	7...4	aux_offset	trigger-readout offset in units of 2.5 ms. If set to zero, the offset is maximum, i.e. after readout a trigger is issued immediately.	0x4	RW

46 Register (0x45) FIFO_DOWNS

DESCRIPTION: Configure Gyroscope and Accelerometer downsampling rates for FIFO
RESET: 0x88
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x45		FIFO_DOWNS		0x88	
	2...0	gyr_fifo_downs	Downsampling for Gyroscope (2**downs_gyro)	0x0	RW
	3	gyr_fifo_filt_data	selects filtered or unfiltered Gyroscope data for fifo **Value Name Description** 0x00 unfiltered Unfiltered data 0x01 filtered Filtered data	0x1	RW
	6...4	acc_fifo_downs	Downsampling for Accelerometer (2**downs_accel)	0x0	RW
	7	acc_fifo_filt_data	selects filtered or unfiltered Accelerometer data for fifo **Value Name Description** 0x00 unfiltered Unfiltered data 0x01 filtered Filtered data	0x1	RW

47 Register (0x46) FIFO_WTM_0

DESCRIPTION: FIFO Watermark level LSB
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x46		FIFO_WTM_0		0x00	
	7...0	fifo_water_mark_7_0	Trigger an interrupt when FIFO contains fifo_water_mark_7_0+fifo_water_mark_12_8*256 bytes	0x0	RW

48 Register (0x47) FIFO_WTM_1

DESCRIPTION: FIFO Watermark level MSB and frame content configuration
RESET: 0x02
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x47		FIFO_WTM_1		0x02	
	4...0	fifo_water_mark_12_8	Trigger an interrupt when FIFO contains fifo_water_mark_7_0+fifo_water_mark_12_8*256 bytes	0x2	RW

49 Register (0x48) FIFO_CONFIG_0

DESCRIPTION: FIFO frame content configuration
RESET: 0x02
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x48		FIFO_CONFIG_0		0x02	
	0	fifo_stop_on_full	Stop writing samples into FIFO when FIFO is full. **Value** **Name** **Description** 0x00 disable do not stop writing to FIFO when full 0x01 enable Stop writing into FIFO when full.	0x0	RW
	1	fifo_time_en	Return sensortime frame after the last valid data frame. **Value** **Name** **Description** 0x00 disable do not return sensortime frame 0x01 enable return sensortime frame	0x1	RW

50 Register (0x49) FIFO_CONFIG_1

DESCRIPTION: FIFO frame content configuration
RESET: 0x10
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x49		FIFO_CONFIG_1		0x10	
	1...0	fifo_tag_int1_en	FIFO interrupt 1 tag enable **Value** **Name** **Description** 0x00 int_edge enable tag on rising edge of int pin 0x01 int_level enable tag on level value of int pin 0x02 acc_sat enable tag on saturation of accelerometer data 0x03 gyr_sat enable tag on saturation of gyroscope data	0x0	RW
	3...2	fifo_tag_int2_en	FIFO interrupt 2 tag enable **Value** **Name** **Description** 0x00 int_edge enable tag on rising edge of int pin 0x01 int_level enable tag on level value of int pin 0x02 acc_sat enable tag on saturation of accelerometer data 0x03 gyr_sat enable tag on saturation of gyroscope data	0x0	RW
	4	fifo_header_en	FIFO frame header enable **Value** **Name** **Description** 0x00 disable no header is stored (output data rate of all enabled sensors need to be identical) 0x01 enable header is stored	0x1	RW
	5	fifo_aux_en	Store Auxiliary sensor data in FIFO (all 3 axes) **Value** **Name** **Description** 0x00 disable no Auxiliary sensor data is stored 0x01 enable Auxiliary sensor data is stored	0x0	RW
	6	fifo_acc_en	Store Accelerometer data in FIFO (all 3 axes)	0x0	RW

			Value **Name** **Description** 0x00 disable no Accelerometer data is stored 0x01 enable Accelerometer data is stored		
	7	fifo_gyr_en	Store Gyroscope data in FIFO (all 3 axes) **Value** **Name** **Description** 0x00 disable no Gyroscope data is stored 0x01 enable Gyroscope data is stored	0x0	RW

51 Register (0x4A) SATURATION

DESCRIPTION: Contains the information if one of the raw data samples used to generate current filtered data sample has been saturated (reached 0x8001 or 0x7FFF). The register is updated synchronous to the corresponding data registers in DATA_0..19.
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x4A		SATURATION		0x00	
	0	acc_x	ACC X-axis raw data saturation flag.	0x0	R
	1	acc_y	ACC Y-axis raw data saturation flag.	0x0	R
	2	acc_z	ACC Z-axis raw data saturation flag.	0x0	R
	3	gyr_x	GYR X-axis raw data saturation flag.	0x0	R
	4	gyr_y	GYR Y-axis raw data saturation flag.	0x0	R
	5	gyr_z	GYR Z-axis raw data saturation flag.	0x0	R

52 Register (0x4B) AUX_DEV_ID

DESCRIPTION: Auxiliary interface device_id
RESET: 0x20
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x4B		AUX_DEV_ID		0x20	
	7...1	i2c_device_addr	I2C device address of Auxiliary sensor	0x10	RW

53 Register (0x4C) AUX_IF_CONF

DESCRIPTION: Auxiliary interface configuration register
RESET: 0x83
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x4C		AUX_IF_CONF		0x83	
	1...0	aux_rd_burst	Burst data length (1,2,6,8 byte) **Value Name Description** 0x00 BL1 Burst length 1 0x01 BL2 Burst length 2 0x02 BL6 Burst length 6 0x03 BL8 Burst length 8	0x3	RW
	3...2	man_rd_burst	Manual burst data length (1,2,6,8 byte) **Value Name Description** 0x00 BL1 Burst length 1 0x01 BL2 Burst length 2 0x02 BL6 Burst length 6 0x03 BL8 Burst length 8	0x0	RW
	6	aux_fcu_write_en	enables FCU write command on AUX IF for auxiliary sensors that need a trigger.	0x0	RW
	7	aux_manual_en	switches auxiliary interface between automatic and manual mode. In manual mode all read and write operations on auxiliary interface must be triggered manually; in automatic mode (aux_manual_en = “0”) FCU triggers read and write operations periodically (as programmed by user).	0x1	RW

54 Register (0x4D) AUX_RD_ADDR

DESCRIPTION: Auxiliary interface read address
RESET: 0x42
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x4D		AUX_RD_ADDR		0x42	
	7...0	read_addr	Address to read. In manual mode it triggers the read operation.	0x42	RW

55 Register (0x4E) AUX_WR_ADDR

DESCRIPTION: Auxiliary interface write address
RESET: 0x4C
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x4E		AUX_WR_ADDR		0x4C	
	7...0	write_addr	Address to write. In manual mode it triggers the write operation.	0x4C	RW

56 Register (0x4F) AUX_WR_DATA

DESCRIPTION: Auxiliary interface write data
RESET: 0x02
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x4F		AUX_WR_DATA		0x02	
	7...0	write_data	Data to write	0x2	RW

57 Register (0x52) ERR_REG_MSK

DESCRIPTION: Defines which error flag will trigger the error interrupt once enabled
'1' - use to generate the error interrupt
'0' - do not use to generate error interrupt
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x52		ERR_REG_MSK		0x00	
	0	fatal_err	Use fatal error to generate the error interrupt.	0x0	RW
	4...1	internal_err	Use internal error to generate the error interrupt	0x0	RW
	6	fifo_err	Use fifo error to generate the error interrupt.	0x0	RW
	7	aux_err	Use aux interface error to generate the error interrupt.	0x0	RW

58 Register (0x53) INT1_IO_CTRL

DESCRIPTION: Configure the electrical behavior of the interrupt pin INT1
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x53		INT1_IO_CTRL		0x00	
	1	lvl	Configure output level of INT1 pin **Value Name Description** 0x00 active_low active low 0x01 active_high active high	0x0	RW
	2	od	Configure output behaviour of INT1 pin **Value Name Description** 0x00 push_pull push-pull 0x01 open_drain open drain	0x0	RW
	3	output_en	Output enable for INT1 pin **Value Name Description** 0x00 off Output disabled 0x01 on Output enabled	0x0	RW
	4	input_en	Input enable for INT1 pin **Value Name Description** 0x00 off Input disabled 0x01 on Input enabled	0x0	RW

59 Register (0x54) INT2_IO_CTRL

DESCRIPTION: Configure the electrical behavior of the interrupt pin INT2
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x54		INT2_IO_CTRL		0x00	
	1	lvl	Configure level of INT2 pin **Value Name Description** 0x00 active_low active low 0x01 active_high active high	0x0	RW
	2	od	Configure output behaviour of INT2 pin **Value Name Description** 0x00 push_pull push-pull 0x01 open_drain open drain	0x0	RW
	3	output_en	Output enable for INT2 pin **Value Name Description** 0x00 off Output disabled 0x01 on Output enabled	0x0	RW
	4	input_en	Input enable for INT2 pin **Value Name Description** 0x00 off Input disabled 0x01 on Input enabled	0x0	RW

60 Register (0x55) INT_LATCH

DESCRIPTION: Configure interrupt latch modes
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x55		INT_LATCH		0x00	
	0	int_latch	Latched/non-latched interrupt modes **Value** **Name** **Description** 0x00 none non latched 0x01 permanent permanent latched	0x0	RW

61 Register (0x56) INT1_MAP_FEAT

DESCRIPTION: Interrupt/Feature mapping on INT1
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x56		INT1_MAP_FEAT		0x00	
	0	sig_motion_out	Sigmotion output.	0x0	RW
	1	step_counter_out	Step-counter watermark or Step-detector output or Step activity output	0x0	RW
	2	high_low_g_out	High-g and Low-g detection output	0x0	RW
	3	tap_out	Tap output	0x0	RW
	4	flat_out	Flat output	0x0	RW
	5	no_motion_out	No motion detection output	0x0	RW
	6	any_motion_out	Any motion detection output	0x0	RW
	7	orientation_out	Orientation output	0x0	RW

62 Register (0x57) INT2_MAP_FEAT

DESCRIPTION: Interrupt/Feature mapping on INT2
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x57		INT2_MAP_FEAT		0x00	
	0	sig_motion_out	Sigmotion output.	0x0	RW
	1	step_counter_out	Step-counter watermark or Step-detector output or Step activity output	0x0	RW
	2	high_low_g_out	High-g and Low-g detection output	0x0	RW
	3	tap_out	Tap output	0x0	RW
	4	flat_out	Flat output	0x0	RW
	5	no_motion_out	No motion detection output	0x0	RW
	6	any_motion_out	Any motion detection output	0x0	RW
	7	orientation_out	Orientation output	0x0	RW

63 Register (0x58) INT_MAP_DATA

DESCRIPTION: Data Interrupt mapping for both INT pins
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x58		INT_MAP_DATA		0x00	
	0	ffull_int1	FIFO Full interrupt mapped to INT1	0x0	RW
	1	fwm_int1	FIFO Watermark interrupt mapped to INT1	0x0	RW
	2	drdy_int1	Data Ready interrupt mapped to INT1	0x0	RW
	3	err_int1	Error interrupt mapped to INT1	0x0	RW
	4	ffull_int2	FIFO Full interrupt mapped to INT2	0x0	RW
	5	fwm_int2	FIFO Watermark interrupt mapped to INT2	0x0	RW
	6	drdy_int2	Data Ready interrupt mapped to INT2	0x0	RW
	7	err_int2	Error interrupt mapped to INT2	0x0	RW

64 Register (0x59) INIT_CTRL

DESCRIPTION: Start initialization
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x59		INIT_CTRL		0x00	
	7...0	init_ctrl	Start initialization	0x0	RW

65 Register (0x5B) INIT_ADDR_0

DESCRIPTION: Base address of the initialization data. Increment by burst write length in bytes/2 after each burst write operation. Please ignore, if your host supports to load the initialization data in a single 8kB burst write operation.
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x5B		INIT_ADDR_0		0x00	
	3...0	base_0_3	Bits 0 to 3 of the base address for initialization data.	0x0	RW

66 Register (0x5C) INIT_ADDR_1

DESCRIPTION: Base address of the initialization data. Increment by burst write length in bytes/2 after each burst write operation. Please ignore, if your host supports to load the initialization data in a single 8kB burst write operation.
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x5C		INIT_ADDR_1		0x00	
	7...0	base_11_4	Bits 4 to 11 of the base address for initialization data.	0x0	RW

67 Register (0x5E) INIT_DATA

DESCRIPTION: Initialization register
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x5E		INIT_DATA		0x00	
	7...0	data	Register for initialization data	0x0	RW

68 Register (0x5F) INTERNAL_ERROR

DESCRIPTION: Internal error flags. Value of all reserved bits should be ignored.
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x5F		INTERNAL_ERROR		0x00	
	1	int_err_1	Internal error flag - long processing time, processing halted	0x0	R
	2	int_err_2	Internal error flag - fatal error, processing halted	0x0	R
	4	feat_eng_disabled	Feature engine has been disabled by host during sensor operation	0x0	R

69 Register (0x68) AUX_IF_TRIM

DESCRIPTION: Auxiliary interface trim register (NVM backed)
RESET: 0x01
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x68		AUX_IF_TRIM		0x01	
	1...0	asda_pupsel	Pullup configuration for ASDA **Value Name Description** 0x00 pup_res_off Pullup off 0x01 pup_res_40k Pullup 40k 0x02 pup_res_10k Pullup 10k 0x03 pup_res_2k Pullup 2k	0x1	RW

70 Register (0x69) GYR_CRT_CONF

DESCRIPTION: Component Retrimming for Gyroscope
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x69		GYR_CRT_CONF		0x00	
	2	crt_running	Indicates that CRT is currently running. If CRT completed, check CRT_STATUS register for the completion status **Value Name Description** 0x00 disabled disabled 0x01 enabled enabled	0x0	RW
	3	rdy_for_dl	pacemaker bit for downloading the CRT data **Value Name Description** 0x00 ongoing ongoing or not started 0x01 complete complete	0x0	R

71 Register (0x6A) NVM_CONF

DESCRIPTION: NVM Configuration
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x6A		NVM_CONF		0x00	
	1	nvm_prog_en	Enable NVM programming. **Value** **Name** **Description** 0x00 disable disable 0x01 enable enable	0x0	RW

72 Register (0x6B) IF_CONF

DESCRIPTION: Serial interface settings
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x6B		IF_CONF		0x00	
	0	spi3	Configure SPI Interface Mode for primary interface **Value** **Name** **Description** 0x00 spi4 SPI 4-wire mode 0x01 spi3 SPI 3-wire mode	0x0	RW
	1	spi3_ois	Configure SPI Interface Mode for OIS interface (if enabled) **Value** **Name** **Description** 0x00 spi4 SPI 4-wire mode 0x01 spi3 SPI 3-wire mode	0x0	RW
	4	ois_en	Interface configuration - OIS enable bit. It has lower priority than aux_en.	0x0	RW
	5	aux_en	Interface configuration - AUX enable bit. It has higher priority than ois_en.	0x0	RW

73 Register (0x6C) DRV

DESCRIPTION: Drive strength control register (NVM backed)
RESET: 0xFF
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x6C		DRV		0xFF	
	2...0	io_pad_drv1	Output pad drive strength setting.	0x7	RW
	3	io_pad_i2c_b1	Output pad drive strength setting.	0x1	RW
	6...4	io_pad_drv2	Output pad drive strength setting.	0x7	RW
	7	io_pad_i2c_b2	Output pad drive strength setting.	0x1	RW

74 Register (0x6D) ACC_SELF_TEST

DESCRIPTION: Settings for the accelerometer self-test configuration and trigger
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x6D		ACC_SELF_TEST		0x00	
	0	acc_self_test_en	Enable accelerometer self-test **Value Name Description** 0x00 disabled disabled 0x01 enabled enabled	0x0	RW
	2	acc_self_test_sign	select sign of self-test excitation as **Value Name Description** 0x00 negative negative 0x01 positive positive	0x0	RW
	3	acc_self_test_amp	select amplitude of the selftest deflection: **Value Name Description** 0x00 low low 0x01 high high	0x0	RW

75 Register (0x6E) GYR_SELF_TEST_AXES

DESCRIPTION: Settings for the gyroscope AXES self-test configuration and trigger
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x6E		GYR_SELF_TEST_AXES		0x00	
	0	gyr_st_axes_done	STATUS: functional test of detection channels finished.	0x0	R
	1	gyr_axis_x_ok	status of gyro X-axis self test	0x0	R
	2	gyr_axis_y_ok	status of gyro Y-axis self test	0x0	R
	3	gyr_axis_z_ok	status of gyro Z-axis self test	0x0	R

76 Register (0x70) NV_CONF

DESCRIPTION: NVM backed configuration bits.
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x70		NV_CONF		0x00	
	0	spi_en	disable the I2C and enable SPI for the primary interface, when it is in autoconfig mode **Value** **Name** **Description** 0x00 disabled I2C enabled 0x01 enabled I2C disabled	0x0	RW
	1	i2c_wdt_sel	Select timer period for I2C Watchdog **Value** **Name** **Description** 0x00 short I2C watchdog timeout after 1.25 ms 0x01 long I2C watchdog timeout after 40 ms	0x0	RW
	2	i2c_wdt_en	I2C Watchdog at the SDA pin in I2C interface mode **Value** **Name** **Description** 0x00 Disable Disable I2C watchdog 0x01 Enable Enable I2C watchdog	0x0	RW
	3	acc_off_en	Add the offset defined in the off_acc_[xyz] OFFSET register to filtered and unfiltered Accelerometer data **Value** **Name** **Description** 0x00 disabled Disabled 0x01 enabled Enabled	0x0	RW

77 Register (0x71) OFFSET_0

DESCRIPTION: Offset compensation for Accelerometer X-axis (NVM backed)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x71		OFFSET_0		0x00	
	7...0	off_acc_x	Accelerometer offset compensation (X-axis).	0x0	RW

78 Register (0x72) OFFSET_1

DESCRIPTION: Offset compensation for Accelerometer Y-axis (NVM backed)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x72		OFFSET_1		0x00	
	7...0	off_acc_y	Accelerometer offset compensation (Y-axis).	0x0	RW

79 Register (0x73) OFFSET_2

DESCRIPTION: Offset compensation for Accelerometer Z-axis (NVM backed)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x73		OFFSET_2		0x00	
	7...0	off_acc_z	Accelerometer offset compensation (Z-axis).	0x0	RW

80 Register (0x74) OFFSET_3

DESCRIPTION: Offset compensation for Gyroscope X-axis (NVM backed)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x74		OFFSET_3		0x00	
	7...0	gyr_usr_off_x_7_0	Gyroscope offset compensation (X-axis).	0x0	RW

81 Register (0x75) OFFSET_4

DESCRIPTION: Offset compensation for Gyroscope Y-axis (NVM backed)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x75		OFFSET_4		0x00	
	7...0	gyr_usr_off_y_7_0	Gyroscope offset compensation (Y-axis).	0x0	RW

82 Register (0x76) OFFSET_5

DESCRIPTION: Offset compensation for Gyroscope Z-axis (NVM backed)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x76		OFFSET_5		0x00	
	7...0	gyr_usr_off_z_7_0	Gyroscope offset compensation (Z-axis).	0x0	RW

83 Register (0x77) OFFSET_6

DESCRIPTION: Offset compensation (MSBs gyroscope, enables) (NVM backed)
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x77		OFFSET_6		0x00	
	1...0	gyr_usr_off_x_9_8	Gyroscope offset compensation (X-axis).	0x0	RW
	3...2	gyr_usr_off_y_9_8	Gyroscope offset compensation (Y-axis).	0x0	RW
	5...4	gyr_usr_off_z_9_8	Gyroscope offset compensation (Z-axis).	0x0	RW
	6	gyr_off_en	Add the offset defined in the gyr_usr_off_[xyz] OFFSET register to filtered and unfiltered Gyroscope data **Value Name Description** 0x00 disabled Disabled 0x01 enabled Enabled	0x0	RW
	7	gyr_gain_en	Compensate the gain as described in section "Sensitivity Error Compensation". **Value Name Description** 0x00 disabled Disabled 0x01 enabled Enabled	0x0	RW

84 Register (0x7C) PWR_CONF

DESCRIPTION: Power mode configuration register
RESET: 0x03
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x7C		PWR_CONF		0x03	
	0	adv_power_save	Advanced power save disabled. **Value** **Name** **Description** 0x00 aps_off Advanced power save disabled. 0x01 aps_on Advanced power mode enabled.	0x1	RW
	1	fifo_self_wake_up	FIFO read disabled in low power mode **Value** **Name** **Description** 0x00 fsw_off FIFO read disabled in low power mode 0x01 fsw_on FIFO read enabled in low power mode after FIFO interrupt is fired	0x1	RW
	2	fup_en	Fast power up enable **Value** **Name** **Description** 0x00 fup_off Fast power up disabled 0x01 fup_on Fast power up enabled	0x0	RW

85 Register (0x7D) PWR_CTRL

DESCRIPTION: Power mode control register
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x7D		PWR_CTRL		0x00	
	0	aux_en	**Value** **Name** **Description** 0x00 aux_off Disables the Auxiliary sensor. 0x01 aux_on Enables the Auxiliary sensor.	0x0	RW
	1	gyr_en	**Value** **Name** **Description** 0x00 gyr_off Disables the Gyroscope. 0x01 gyr_on Enables the Gyroscope.	0x0	RW
	2	acc_en		0x0	RW

			Value **Name** **Description** 0x00 acc_off Disables the Accelerometer. 0x01 acc_on Enables the Accelerometer.		
	3	temp_en	**Value** **Name** **Description** 0x00 temp_off Disables the Temperature sensor. 0x01 temp_on Enables the Temperature sensor.	0x0	RW

86 Register (0x7E) CMD

DESCRIPTION: Command Register
RESET: 0x00
DEFINITION (Go to register map):

Address	Bit	Name	Description	Reset	Access
0x7E		CMD		0x00	
	7...0	cmd	Available commands (Note: Register will always return 0x00 as read result): **Value** **Name** **Description** 0x02 g_trigger Trigger special gyro operations. 0x03 usr_gain Applies new gyro gain value. 0xa0 nvm_prog Writes the NVM backed registers into NVM 0xb0 fifo_flush Clears FIFO content 0xb6 softreset Triggers a reset, all user configuration settings are overwritten with their default state	0x0	W

5. Legal disclaimer

5.1. Engineering samples

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6. Document History and Modification

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Bosch Sensortec GmbH
Gerhard-Kindler-Straße 9
72770 Reutlingen / Germany

contact@bosch-sensortec.com
www.bosch-sensortec.com

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