LSM6DSV16X

Datasheet

6-axis inertial measurement unit (IMU) and AI sensor with embedded sensor fusion, Qvar for high-end applications



LGA-14L
(2.5 x 3.0 x 0.83 mm) typ.

Qvar

Product status link
LSM6DSV16X

Product summary		
Order code	LSM6DSV16X	LSM6DSV16XTR
Temp. range [°C]	-40 to +85	
Package	LGA-14L (2.5 x 3.0 x 0.83 mm)	
Packing	Tray	Tape and reel

Product resources
AN5763 (device application note)
AN5882 (finite state machine)
AN5804 (machine learning core)
AN5755 (Qvar sensing)
TN0018 (design and soldering)

Product label
SUSTAINABLE TECHNOLOGY

Features

- Triple-channel architecture for UI, EIS, and OIS data processing
- "Always-on" experience with low power consumption for both accelerometer and gyroscope
- Smart FIFO up to 4.5 KB
- Android compliant
- ±2/±4/±8/±16 *g* full scale
- ±125/±250/±500/±1000/±2000/±4000 dps full scale
- SPI / I²C & MIPI I3C® v1.1 serial interface with main processor data synchronization
- Auxiliary SPI for OIS data output for gyroscope and accelerometer
- OIS configurable from aux. SPI, primary interface (SPI / I²C & MIPI I3C® v1.1)
- EIS dedicated channel on primary interface with dedicated filtering
- Advanced pedometer, step detector, and step counter
- Significant motion detection, tilt detection
- Standard interrupts: free-fall, wake-up, 6D/4D orientation, click and double click
- Programmable finite state machine for accelerometer, gyroscope, and external sensor data processing with high rate @ 960 Hz
- Machine learning core with exportable features and filters for AI applications
- Embedded adaptive self-configuration (ASC)
- Embedded Qvar (electrostatic sensor) for user interface functions (tap, double tap, triple tap, long press, L/R – R/L swipe)
- Embedded analog hub for ADC and processing analog input data
- Embedded sensor fusion low-power algorithm
- Embedded temperature sensor
- Analog supply voltage: 1.71 V to 3.6 V
- Independent IO supply (extended range: 1.08 V to 3.6 V)
- Power consumption: 0.65 mA in combo high-performance mode
- Compact footprint: 2.5 mm x 3 mm x 0.83 mm
- ECOPACK and RoHS compliant

Applications

- Motion tracking and gesture detection, augmented reality (AR) / virtual reality (VR) / mixed reality (MR) applications & metaverse applications
- Wearables
- Indoor navigation
- IoT and connected devices
- Smartphones and handheld devices
- EIS and OIS for camera applications
- Vibration monitoring and compensation

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Description

The LSM6DSV16X is a high-performance, low-power 6-axis small IMU, featuring a 3-axis digital accelerometer and a 3-axis digital gyroscope, that offers the best IMU sensor with a triple-channel architecture for processing acceleration and angular rate data on three separate channels (user interface, OIS, and EIS) with dedicated configuration, processing, and filtering.

The LSM6DSV16X enables processes in edge computing, leveraging embedded advanced dedicated features such as a finite state machine (FSM) for configurable motion tracking and a machine learning core (MLC) for context awareness with exportable AI features for IoT applications.

The LSM6DSV16X supports the adaptive self-configuration (ASC) feature, which allows the FSM to automatically reconfigure the device in real time based on the detection of a specific motion pattern or based on the output of a specific decision tree configured in the MLC, without any intervention from the host processor.

The LSM6DSV16X embeds Qvar (electric charge variation detection) for user interface functions like tap, double tap, triple tap, long press, or L/R – R/L swipe.

The LSM6DSV16X embeds an analog hub able to connect an external analog input and convert it to a digital signal for processing.

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1 Overview

The LSM6DSV16X is a system-in-package featuring a high-performance 3-axis digital accelerometer and 3-axis digital gyroscope.

The LSM6DSV16X delivers best-in-class motion sensing that can detect orientation and gestures in order to empower application developers and consumers with features and capabilities that are more sophisticated than simply orienting their devices to portrait and landscape mode.

The event-detection interrupts enable efficient and reliable motion tracking and context awareness, implementing hardware recognition of free-fall events, 6D orientation, click and double-click sensing, activity or inactivity, stationary/motion detection and wake-up events. Machine learning and finite state machine processing allow moving some algorithms from the application processor to the LSM6DSV16X sensor, enabling consistent reduction of power consumption.

The LSM6DSV16X supports the main OS requirements, offering real, virtual, and batch mode sensors. In addition, the LSM6DSV16X can efficiently run the sensor-related features specified in Android, saving power and enabling faster reaction time. In particular, the LSM6DSV16X has been designed to implement hardware features such as significant motion detection, stationary/motion detection, tilt, pedometer functions, timestamping and to support the data acquisition of external sensors.

The LSM6DSV16X offers hardware flexibility to connect the pins with different mode connections to external sensors to expand functionalities such as adding a sensor hub, auxiliary SPI, and so forth.

The LSM6DSV16X offers advanced design flexibility for OIS and EIS applications. Both channels have a dedicated processing path with independent filtering and enhanced EIS channel gyroscope data are read over the primary interfaces I²C/ MIPI I3C® v1.1 / SPI.

Channel 1 has been designed for user interface data processing for motion tracking. Data are available on the primary output of I²C / SPI / I3C® for the accelerometer and gyroscope with independent ODR and FS.

Channel 2 has been designed for OIS applications. Data are available on the aux SPI at 7.68 kHz with accelerometer/gyroscope processing with independent FS at ±2 *g* - ±16 *g* (accelerometer) / ±125 dps - ±2000 dps (gyroscope). The accelerometer is also available as standalone with dedicated filtering.

Channel 3 has been design for enhanced EIS. Data are available in freerun mode in the output registers or in FIFO with dedicated tag and timestamp.

Up to 4.5 KB of FIFO with compression and dynamic allocation of significant data (that is, external sensors, timestamp, and so forth) allows overall power saving of the system.

The LSM6DSV16X embeds a sensor fusion low-power (SFLP) algorithm able to provide a 6-axis (accelerometer + gyroscope) game rotation vector represented as a quaternion. The X, Y, Z quaternion components are stored in FIFO.

Like the entire portfolio of MEMS sensor modules, the LSM6DSV16X leverages the robust and mature in-house manufacturing processes already used for the production of micromachined accelerometers and gyroscopes. The various sensing elements are manufactured using specialized micromachining processes, while the IC interfaces are developed using CMOS technology that allows the design of a dedicated circuit, which is trimmed to better match the characteristics of the sensing element.

The LSM6DSV16X embeds an analog hub, which is able to connect an external analog input and convert it to a digital signal for processing as well as advanced dedicated features like a finite state machine and data filtering for OIS, EIS, and motion processing.

The LSM6DSV16X embeds Qvar functionality, which is an electrostatic sensor able to measure the variation of the quasi-electrostatic potential. The Qvar sensing channel can be used for user interface applications like tap, double tap, triple tap, long press, and L/R – R/L swipe.

The LSM6DSV16X is available in a small plastic land grid array (LGA) package of 2.5 x 3.0 x 0.83 mm to address ultracompact solutions.

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2 Embedded low-power features

The LSM6DSV16X has been designed to be fully compliant with Android, featuring the following on-chip functions:

- 4.5 KB FIFO data buffering, data can be compressed two or three times
  - 100% efficiency with flexible configurations and partitioning
  - Possibility to store timestamp
- Event-detection interrupts (fully configurable)
  - Free-fall
  - Wake-up
  - 6D orientation
  - Click and double-click sensing
  - Activity/inactivity recognition
  - Stationary/motion detection
- Specific IP blocks (called "embedded functions") with negligible power consumption and high performance
  - Pedometer functions: step detector and step counters
  - Tilt
  - Significant motion detection
  - Finite state machine (FSM)
  - Machine learning core (MLC) with exportable features and filters for AI applications
  - Adaptive self-configuration (ASC)
  - Embedded sensor fusion low-power (SFLP) algorithm
- Sensor hub
  - Up to six total sensors: two internal (accelerometer and gyroscope) and four external sensors
- Analog hub for processing external analog input data
- Qvar: electric charge variation detection

2.1 Pedometer functions: step detector and step counters

The LSM6DSV16X embeds an advanced pedometer with an algorithm running in an ultralow-power domain in order to ensure extensive battery life in battery-constrained applications.

Leveraging enhanced configurability, the advanced embedded pedometer is suitable for a large range of applications from mobile to wearable devices.

The algorithm processes and analyzes the accelerometer waveform in order to count the user's steps during walking and running activities.

The pedometer works at 30 Hz and it is not affected by the selected device power mode (ultralow-power, low-power, high-performance), thus guaranteeing an ultralow-power experience and extreme flexibility in conjunction with other device functionalities.

The pedometer output can be batched in the device's FIFO buffer, in order to decrease overall system current consumption.

ST freely provides the support and the tools for easily configuring the device and tuning the algorithm configuration for a best-in-class user experience.

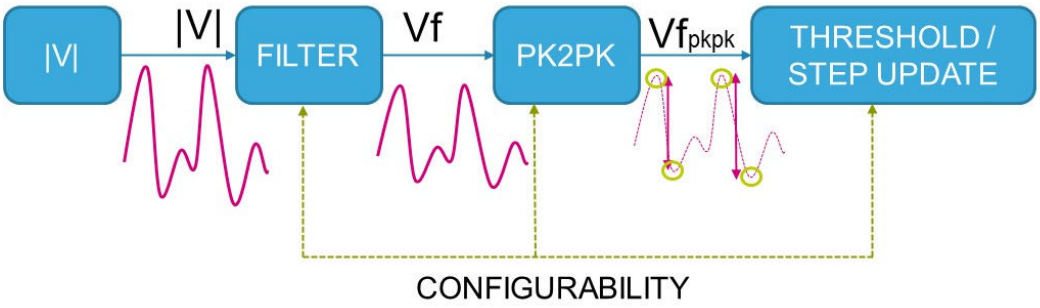
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2.2 Pedometer algorithm

The pedometer algorithm is composed of a cascade of four stages:

1. Computation of the acceleration magnitude signal in order to detect the signal independently from device orientation;
2. FIR filter to extract relevant frequency components and to smooth the signal by cutting off high frequencies;
3. Peak detector to find the maximum and minimum of the waveform and compute the peak-to-peak value;
4. Step count: if the peak-to-peak value is greater than the settled threshold, a step is counted.

Figure 1. Four-stage pedometer algorithm



The LSM6DSV16X embeds a dynamic internal threshold for step detection that is updated after each peak-to-peak evaluation: the internal threshold is increased with a configurable speed if a step is detected or decreased with a configurable speed if a step is not detected.

This approach ensures high accuracy when the user starts to walk and a false peak rejection when the user is walking or running.

An internal configurable debounce algorithm can be also set to filter false walks: indeed, an accelerometer pattern is recognized as a walk or run only if a minimum number of steps are counted.

The LSM6DSV16X has been designed to reject a false-positive signal inside the algorithm core.

On top of the mechanisms detailed above, the LSM6DSV16X allows enabling and configuring a dedicated false-positive rejection block to further boost pedometer accuracy.

2.3 Tilt detection

The tilt function helps to detect activity change and has been implemented in hardware using only the accelerometer to achieve targets of both ultralow power consumption and robustness during the short duration of dynamic accelerations.

The tilt function is based on a trigger of an event each time the device's tilt changes and can be used with different scenarios, for example:

- Triggers when a phone is in a front pants pocket and the user goes from sitting to standing or standing to sitting;
- Does not trigger when a phone is in a front pants pocket and the user is walking, running, or going upstairs.

2.4 Significant motion detection

The significant motion detection (SMD) function generates an interrupt when a ‘significant motion’, that could be due to a change in user location, is detected. In the LSM6DSV16X device this function has been implemented in hardware using only the accelerometer.

SMD functionality can be used in location-based applications in order to receive a notification indicating when the user is changing location.

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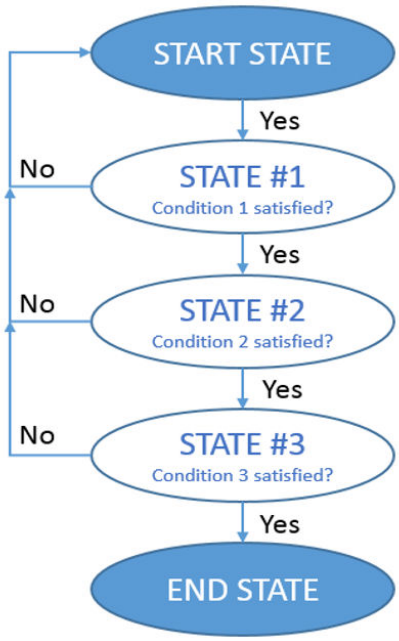
2.5 Finite state machine

The LSM6DSV16X can be configured to generate interrupt signals activated by user-defined motion patterns. To do this, up to 8 embedded finite state machines can be programmed independently for motion detection such as glance gestures, absolute wrist tilt, shake and double-shake detection.

Definition of finite state machine

A state machine is a mathematical abstraction used to design logic connections. It is a behavioral model composed of a finite number of states and transitions between states, similar to a flow chart in which one can inspect the way logic runs when certain conditions are met. The state machine begins with a start state, goes to different states through transitions dependent on the inputs, and can finally end in a specific state (called stop state). The current state is determined by the past states of the system. The following figure shows a generic state machine.

Figure 2. Generic state machine



Finite state machine in the LSM6DSV16X

The LSM6DSV16X works as a combo accelerometer-gyroscope sensor, generating acceleration and angular rate output data. It is also possible to connect an external sensor like a magnetometer or pressure sensor by using the sensor hub feature (mode 2). These data can be used as input of up to 8 programs in the embedded finite state machine (Figure 3. State machine in the LSM6DSV16X).

All 8 finite state machines are independent: each one has its dedicated memory area and it is independently executed. An interrupt is generated when the end state is reached or when some specific command is performed.

Figure 3. State machine in the LSM6DSV16X



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2.6 Machine learning core

The LSM6DSV16X embeds a dedicated core for machine learning processing that provides system flexibility, allowing some algorithms run in the application processor to be moved to the MEMS sensor with the advantage of consistent reduction in power consumption.

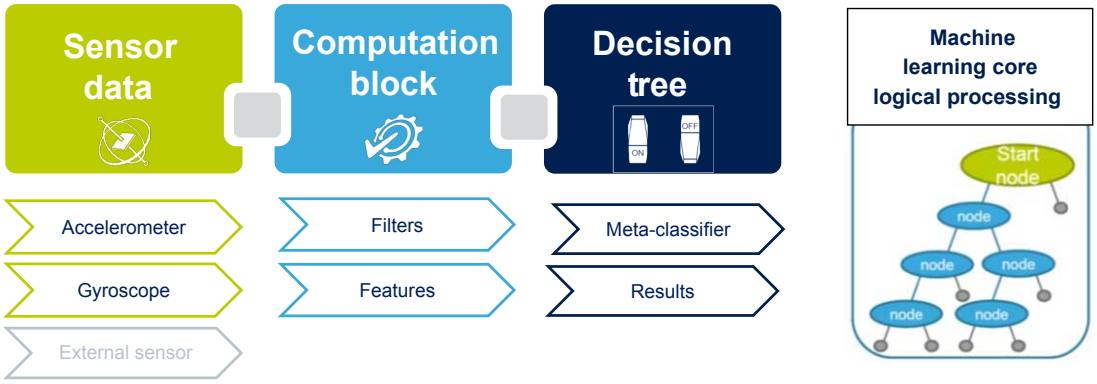
Machine learning core logic allows identifying if a data pattern (for example motion, pressure, temperature, magnetic data, and so forth) matches a user-defined set of classes. Typical examples of applications could be activity detection like running, walking, driving, and so forth.

The LSM6DSV16X machine learning core works on data patterns coming from the accelerometer and gyro sensors, but it is also possible to connect and process external sensor data (like magnetometer or pressure sensor) by using the sensor hub feature (mode 2).

The input data can be filtered using a dedicated configurable computation block containing filters and features computed in a fixed time window defined by the user. Computed feature values and filtered data values can also be read through the FIFO buffer.

Machine learning processing is based on logical processing composed of a series of configurable nodes characterized by "if-then-else" conditions where the "feature" values are evaluated against defined thresholds.

Figure 4. Machine learning core in the LSM6DSV16X



The LSM6DSV16X can be configured to run up to 4 decision trees simultaneously and independently and every decision tree can generate up to 16 results. The total number of nodes can be up to 128.

The results of the machine learning processing are available in dedicated output registers readable from the application processor at any time.

The LSM6DSV16X machine learning core can be configured to generate an interrupt when a change in the result occurs.

2.7 Adaptive self-configuration (ASC)

The LSM6DSV16X supports the adaptive self-configuration (ASC) feature, which allows the FSM to automatically reconfigure the device in real time based on the detection of a specific motion pattern or based on the output of a specific decision tree configured in the MLC, without any intervention from the host processor. The FSM can write a subset of the device registers using the SETR command, which allows indicating the register address and the new value to be written in such a register. The access to these device registers is mutually exclusive to the host.

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2.8 Sensor fusion low power

A sensor fusion low-power (SFLP) block is available in the LSM6DSV16X for generating the following data based on the accelerometer and gyroscope data processing:

- Game rotation vector, which provides a quaternion representing the attitude of the device
- Gravity vector, which provides a three-dimensional vector representing the direction of gravity
- Gyroscope bias, which provides a three-dimensional vector representing the gyroscope bias

The SFLP block is enabled by setting the SFLP_GAME_EN bit to 1 of the EMB_FUNC_EN_A (04h) embedded functions register.

The SFLP block can be reinitialized by setting the SFLP_GAME_INIT bit to 1 of the EMB_FUNC_INIT_A (66h) embedded functions register.

Table 1. Sensor fusion performance

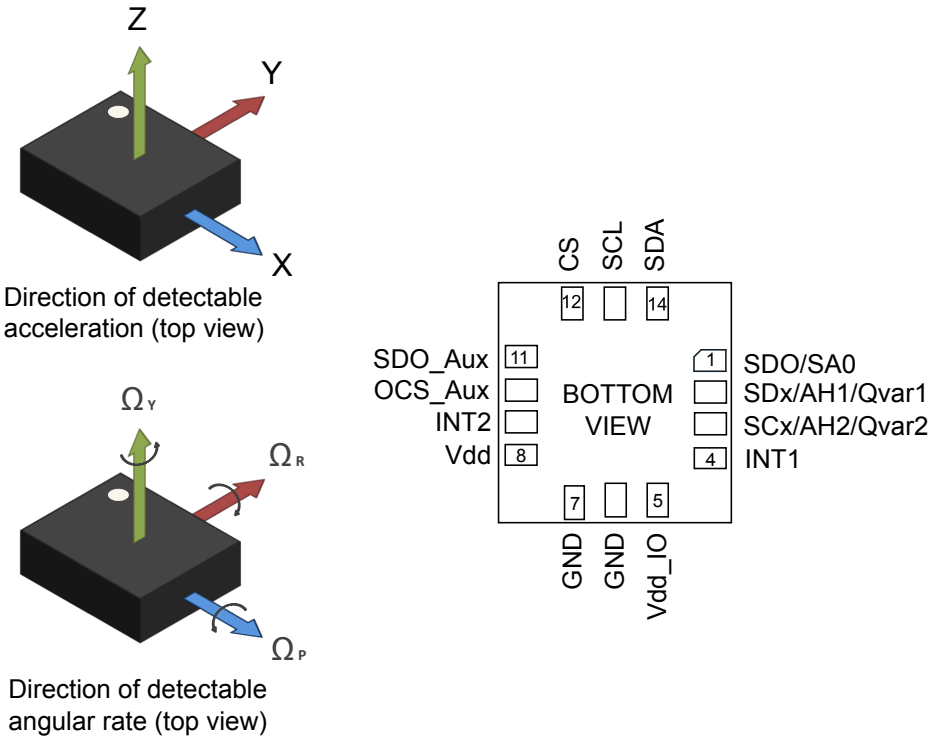
Parameter		Value
Static accuracy	heading / yaw	0.5 deg. / 5 minutes
	pitch	1.5 deg.
	roll	1.5 deg.
Low dynamic accuracy	heading / yaw	0.7 deg. / 5 minutes
	pitch	0.5 deg.
	roll	0.5 deg.
High dynamic accuracy	heading / yaw	5.9 deg. / 5 minutes
	pitch	1.6 deg.
	roll	1.2 deg.
Calibration time		0.8 seconds(1)
Orientation stabilization time		0.7 seconds

1. *Time required to reach steady state*

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3 Pin description

Figure 5. Pin connections



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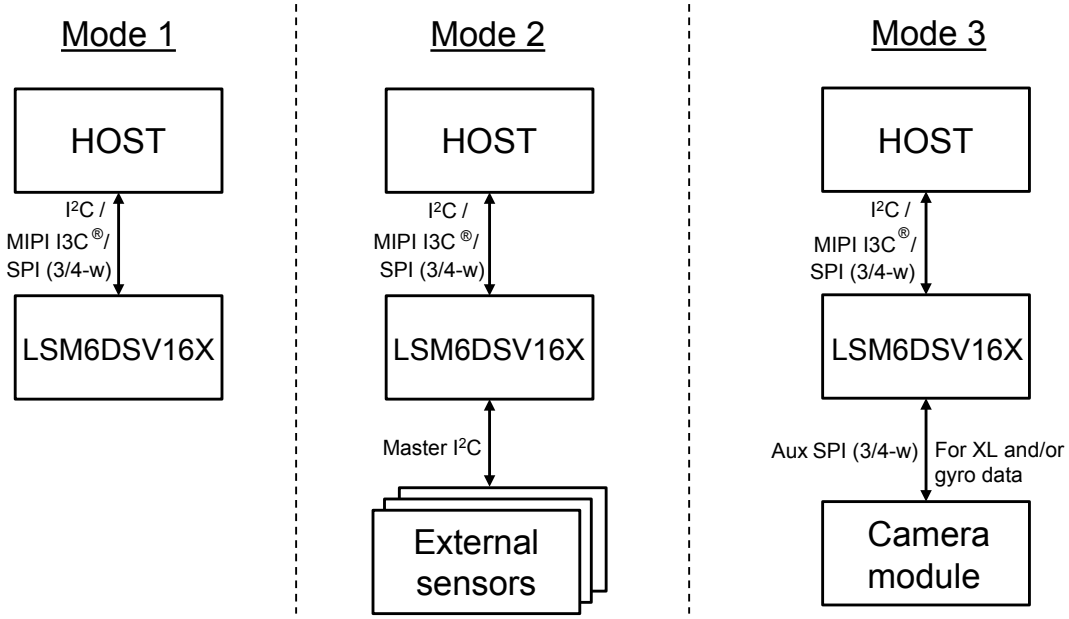
3.1 Pin connections

The LSM6DSV16X offers flexibility to connect the pins in order to have three different mode connections and functionalities. In detail:

- **Mode 1**: I²C / MIPI I3C® slave interface or SPI (3- and 4-wire) serial interface is available. The analog hub and Qvar functionalities are available in mode 1 with I²C interface only.
- **Mode 2**: I²C / MIPI I3C® slave interface or SPI (3- and 4-wire) serial interface and I²C interface master for external sensor connections are available.
- **Mode 3:** I²C / MIPI I3C® slave interface or SPI (3- and 4-wire) serial interface is available for the application processor interface while an auxiliary SPI (3- and 4-wire) serial interface for external sensor connections is available for the accelerometer and gyroscope.

Note: Refer to the product application note for the details regarding operating/power mode configurations, settings, turn-on/off time and on-the-fly changes.

Figure 6. LSM6DSV16X connection modes



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In the following table, each mode is described for the pin connections and function.

Table 2. Pin description

Pin#	Name	Mode 1 function	Mode 2 function	Mode 3 function
1	SDO/SA0(1)	SPI 4-wire interface serial data output (SDO) I²C least significant bit of the device address (SA0)	SPI 4-wire interface serial data output (SDO) I²C least significant bit of the device address (SA0)	SPI 4-wire interface serial data output (SDO) I²C least significant bit of the device address (SA0)
2	SDx/AH1/ Qvar1	Connect to Vdd_IO or GND if the analog hub and Qvar are disabled. AH input 1 (or Qvar electrode 1) is connected if the analog hub (or Qvar functionality) is enabled.	I²C serial data master (MSDA)	Auxiliary SPI 3/4-wire interface serial data input (SDI_Aux) and SPI 3-wire serial data output (SDO_Aux)
3	SCx/AH2/ Qvar2	Connect to Vdd_IO or GND if the analog hub and Qvar are disabled. AH input 2 (or Qvar electrode 2) is connected if the analog hub (or Qvar functionality) is enabled.	I²C serial clock master (MSCL)	Auxiliary SPI 3/4-wire interface serial port clock (SPC_Aux)
4	INT1	Programmable interrupt in I²C and SPI		
5	Vdd_IO(2)	Power supply for I/O pins		
6	GND	0 V supply		
7	GND	0 V supply		
8	Vdd(2)	Power supply		
9	INT2	Programmable interrupt 2 (INT2) / Data enable (DEN)	Programmable interrupt 2 (INT2) / Data enable (DEN) / I²C master external synchronization signal (MDRDY)	Programmable interrupt 2 (INT2) / Data enable (DEN)
10	OCS_Aux	Connect to Vdd_IO or leave unconnected(3)	Connect to Vdd_IO or leave unconnected(3)	Enable auxiliary SPI 3/4-wire interface
11	SDO_Aux	Connect to Vdd_IO or leave unconnected(3)	Connect to Vdd_IO or leave unconnected(3)	Auxiliary SPI 3-wire interface: leave unconnected(3) Auxiliary SPI 4-wire interface: serial data output (SDO_Aux)
12	CS(1)	I²C / MIPI I3C® / SPI mode selection (1: SPI idle mode / I²C / MIPI I3C® communication enabled; 0: SPI communication mode / I²C / MIPI I3C® disabled)	I²C / MIPI I3C® / SPI mode selection (1: SPI idle mode / I²C / MIPI I3C® communication enabled; 0: SPI communication mode / I²C / MIPI I3C® disabled)	I²C / MIPI I3C® / SPI mode selection (1: SPI idle mode / I²C / MIPI I3C® communication enabled; 0: SPI communication mode / I²C / MIPI I3C® disabled)
13	SCL(1)	I²C / MIPI I3C® serial clock (SCL) SPI serial port clock (SPC)	I²C / MIPI I3C® serial clock (SCL) SPI serial port clock (SPC)	I²C / MIPI I3C® serial clock (SCL) SPI serial port clock (SPC)
14	SDA(1)	I²C / MIPI I3C® serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)	I²C / MIPI I3C® serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)	I²C / MIPI I3C® serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)

1. *SPI 3/4-wire interface not available with the analog hub / Qvar functionality enabled.*
2. *Recommended 100 nF filter capacitor.*
3. *Leave pin electrically unconnected and soldered to PCB.*

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4 Module specifications

4.1 Mechanical characteristics

@ Vdd = 1.8 V, T = 25 °C, unless otherwise noted.

Table 3. Mechanical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.(1)	Max.	Unit
LA_FS	Linear acceleration measurement range			±2		*g*
				±4		
				±8		
				±16		
G_FS	Angular rate measurement range			±125		dps
				±250		
				±500		
				±1000		
				±2000		
				±4000		
LA_So	Linear acceleration sensitivity	FS = ±2 *g*		0.061		mg/LSB
		FS = ±4 *g*		0.122		
		FS = ±8 *g*		0.244		
		FS = ±16 *g*		0.488		
G_So	Angular rate sensitivity(2)	FS = ±125 dps		4.375		mdps/LSB
		FS = ±250 dps		8.75		
		FS = ±500 dps		17.50		
		FS = ±1000 dps		35		
		FS = ±2000 dps		70		
		FS = ±4000 dps		140		
G_So%	Sensitivity tolerance(2)	at component level		±0.3		%
LA_SoDr	Linear acceleration sensitivity change vs. temperature(3)	from -40° to +85°		±0.01		%/°C
G_SoDr	Angular rate sensitivity change vs. temperature(3)	from -40° to +85°		±0.007		%/°C
LA_TyOff	Linear acceleration zero-*g* level offset accuracy(4)			±12		mg
G_TyOff	Angular rate zero-rate level(4)			±1		dps
LA_OffDr	Linear acceleration zero-*g* level change vs. temperature(3)			±0.07		mg/°C
G_OffDr	Angular rate typical zero-rate level change vs. temperature(3)			±0.006		dps/°C
Rn	Rate noise density in high-performance mode(5)			2.8		mdps/√Hz
RnRMS	Gyroscope RMS noise in low-power mode(6)			60		mdps RMS
An	Acceleration noise density in high-performance mode(7)	FS = ±2 *g* - ±16 *g*		60		µg/√Hz
	Acceleration noise density in normal mode(8)(9)	FS = ±2 *g* - ±16 *g*		100		
RMS	Accelerometer RMS noise in low-power mode	LPM1		2.3		mg RMS
		LPM2		1.8		
		LPM3		1.2		

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Symbol	Parameter	Test conditions	Min.	Typ.(1)	Max.	Unit
LA_ODR	Linear acceleration output data rate			1.875(10) 7.5 15 30 60 120 240 480 960 1.92 k 3.84 k 7.68 k		Hz
G_ODR	Angular rate output data rate			7.5 15 30 60 120 240 480 960 1.92 k 3.84 k 7.68 k		
HAODR	ODR variation over temperature and supply range in high-accuracy mode(11)	Gyro on			±1	%
		Gyro off			±3	
Vst	Linear acceleration self-test output change(12)(13)(14)		50		1700	mg
	Angular rate self-test output change(15)(16)	FS = ±250 dps	20		80	dps
		FS = ±2000 dps	150		700	dps
Top	Operating temperature range		-40		+85	°C

1. *Typical specifications are not guaranteed.*
2. *Sensitivity tolerance for FS up to ±2000 dps.*
3. *Measurements are performed in a uniform temperature setup and they are based on characterization data in a limited number of samples. Not measured during final test for production.*
4. *Value after calibration.*
5. *Gyroscope rate noise density in high-performance mode is independent of the ODR and FS setting up to ±2000 dps.*
6. *Gyroscope RMS noise in low-power mode is independent of the ODR and FS setting up to ±2000 dps.*
7. *Accelerometer noise density in high-performance mode is independent of the selected ODR and FS. Valid when XL_DualC_EN = 0 in register CTRL8 (17h) .*
8. *Accelerometer noise density in normal mode is independent of the ODR and FS setting. Valid when XL_DualC_EN = 0 in register CTRL8 (17h).*
9. *Noise RMS related to BW = ODR/2.*
10. *This ODR is available when the accelerometer is in low-power mode.*
11. *Values specified by design.*
12. *The sign of the linear acceleration self-test output change is defined by the ST_XL_[1:0] bits in a dedicated register for all axes.*
13. *The linear acceleration self-test output change is defined with the device in stationary condition as the absolute value of: OUTPUT[LSb] (self-test enabled) - OUTPUT[LSb] (self-test disabled). 1LSb = 0.061 mg at ±2 g full scale.*
14. *Accelerometer self-test limits are full-scale independent.*

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15. *The sign of the angular rate self-test output change is defined by the ST_G_[1:0] bits in a dedicated register for all axes.*
16. *The angular rate self-test output change is defined with the device in stationary condition as the absolute value of: OUTPUT[LSb] (self-test enabled) - OUTPUT[LSb] (self-test disabled). 1LSb = 70 mdps at ±2000 dps full scale.*

4.2 Electrical characteristics

@ Vdd = 1.8 V, T = 25 °C, unless otherwise noted.

Table 4. Electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.(1)	Max.	Unit
Vdd	Supply voltage		1.71	1.8	3.6	V
Vdd_IO	Power supply for I/O		1.08		3.6	V
IddHP	Gyroscope and accelerometer current consumption in high-performance mode			0.65		mA
LA_IddHP	Accelerometer current consumption in high-performance mode			190		µA
LA_IddNM	Accelerometer current consumption in normal mode			100		µA
LA_IddLPM2	Accelerometer current consumption in low-power mode (LPM2)	ODR = 60 Hz ODR = 1.875 Hz		20 4.2		µA
LA_IddLPM1	Accelerometer current consumption in low-power mode (LPM1)	ODR = 60 Hz ODR = 1.875 Hz		17 4.0		µA
IddPD	Gyroscope and accelerometer current consumption during power-down			2.6		µA
Ton	Turn-on time - gyroscope			30		ms
V_{IH}	Digital high-level input voltage		0.7 * Vdd_IO			V
V_{IL}	Digital low-level input voltage				0.3 * Vdd_IO	V
V_{OH}	High-level output voltage	I_{OH} = 4 mA(2)	Vdd_IO - 0.2			V
V_{OL}	Low-level output voltage	I_{OL} = 4 mA(2)			0.2	V
Top	Operating temperature range		-40		+85	°C

1. *Typical specifications are not guaranteed.*
2. *4 mA is the maximum driving capability, that is, the maximum DC current that can be sourced/sunk by the digital pin in order to guarantee the correct digital output voltage levels V_{OH} and V_{OL}.*

Table 5. Electrical parameters of Qvar (@Vdd = 1.8 V, T = 25 °C)

Parameter	Typ.(1)	Unit
Power consumption	15(2)	µA
Offset (shorted inputs)	3	mV
Noise (shorted inputs)	54	µV
Qvar gain	78	LSB/mV
CMRR	54	dB
Input impedance	Configurable (from 235 M to 2.4 G)	Ω
Input range	±460	mV

1. *Vdd_IO = 1.8 V, Zin = 235 MOhm. Typical values are based on characterization and are not guaranteed.*
2. *Extra power consumption when only the analog hub / Qvar function is enabled. In this condition the accelerometer must be set to high-performance mode or normal mode.*

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4.3 Temperature sensor characteristics

@ Vdd = 1.8 V, T = 25 °C unless otherwise noted.

Table 6. Temperature sensor characteristics

Symbol	Parameter	Test condition	Min.	Typ. (1)	Max.	Unit
TODR(2)	Temperature refresh rate			60		Hz
Toff	Temperature offset(3)		-15		+15	°C
TSen	Temperature sensitivity			256		LSB/°C
TST	Temperature stabilization time(4)				500	µs
T_ADC_res	Temperature ADC resolution			16		bit
Top	Operating temperature range		-40		+85	°C

1. *Typical specifications are not guaranteed*
2. *When the accelerometer is in low-power mode and the gyroscope part is turned off, the TODR value is equal to the accelerometer ODR.*
3. *The output of the temperature sensor is 0 LSB (typ.) at 25 °C.*
4. *Time from power ON to valid data based on characterization data.*

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4.4 Communication interface characteristics

4.4.1 SPI - serial peripheral interface

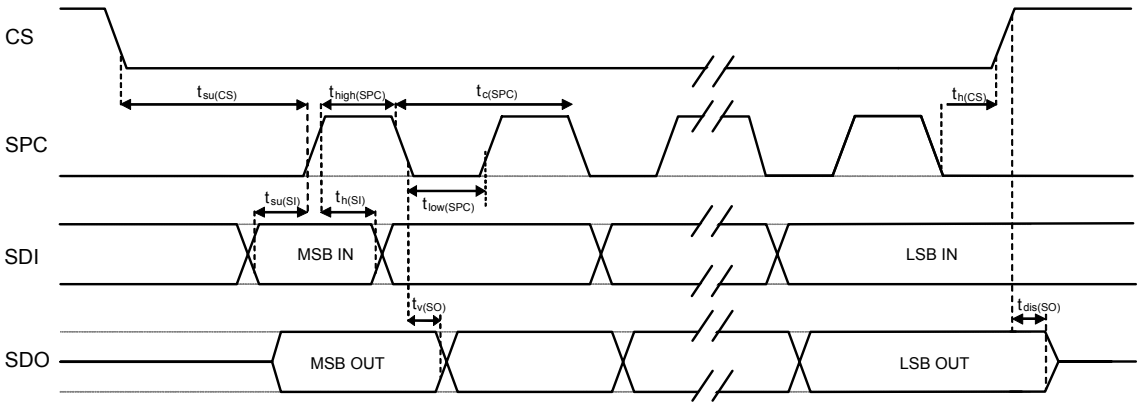
Subject to general operating conditions for Vdd and Top. @ Vdd_IO = 1.8 V, T = 25 °C unless otherwise noted.

Table 7. SPI slave timing values

Symbol	Parameter	Value(1)			Unit
		Min	Typ	Max	
$f_{c(SPC)}$	SPI clock frequency			10	MHz
$t_{c(SPC)}$	SPI clock period	100			ns
$t_{high(SPC)}$	SPI clock high	45			
$t_{low(SPC)}$	SPI clock low	45			
$t_{su(CS)}$	CS setup time (mode 3)	5			
	CS setup time (mode 0)	20			
$t_{h(CS)}$	CS hold time (mode 3)	20			
	CS hold time (mode 0)	20			
$t_{su(SI)}$	SDI input setup time	5			
$t_{h(SI)}$	SDI input hold time	15			
$t_{v(SO)}$	SDO valid output time		15	25	
$t_{dis(SO)}$	SDO output disable time			50	
C_{load}	Bus capacitance			100	pF

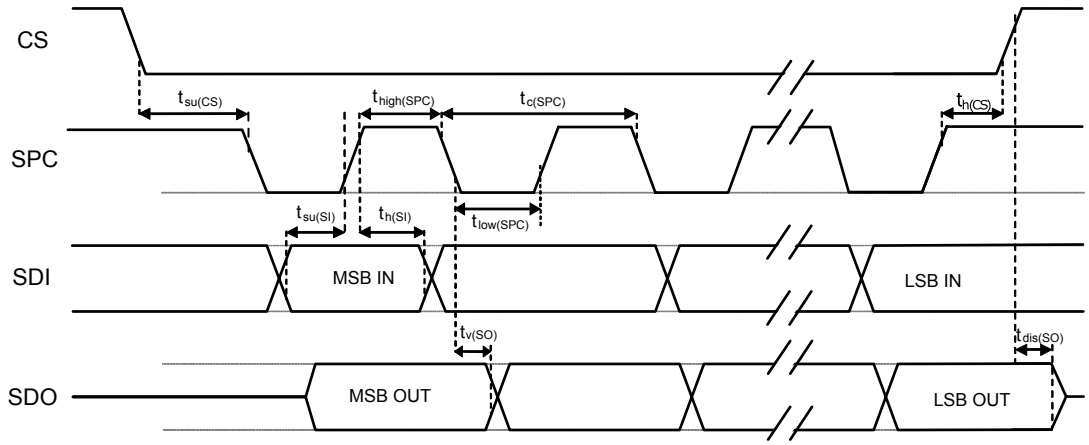
1. *Values are evaluated at 10 MHz clock frequency for SPI with both 4 and 3 wires, based on characterization results, not tested in production*

Figure 7. SPI slave timing in mode 0



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Figure 8. SPI slave timing in mode 3



Note: Measurement points are done at 0.3·Vdd_IO and 0.7·Vdd_IO for both input and output ports.

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4.4.2 I²C - inter-IC control interface

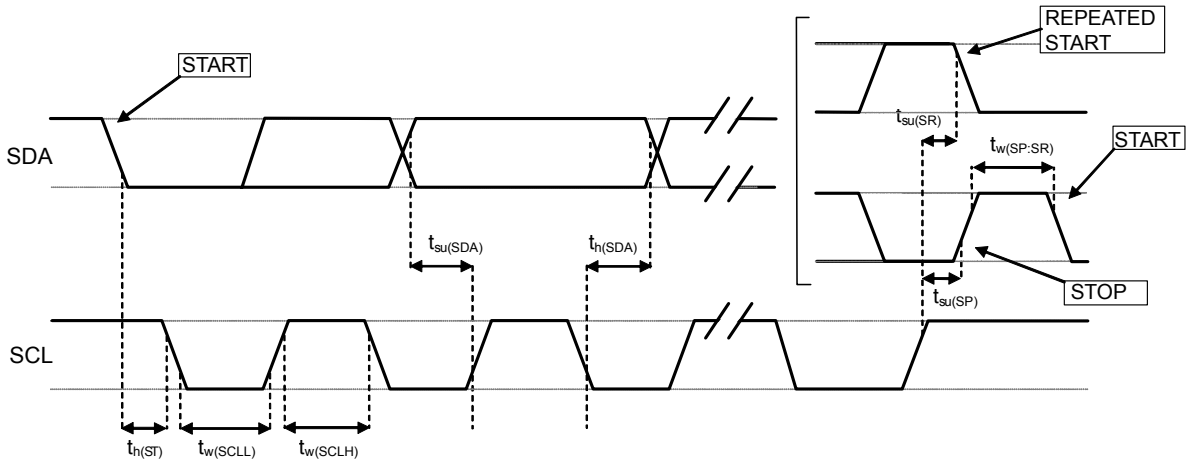
Subject to general operating conditions for Vdd and Top.

Table 8. I²C slave timing values

Symbol	Parameter	I²C fast mode(1)(2)		I²C fast mode plus(1)(2)		Unit
		Min	Max	Min	Max	
$f_{(SCL)}$	SCL clock frequency	0	400	0	1000	kHz
$t_{w(SCLL)}$	SCL clock low time	1.3		0.5		µs
$t_{w(SCLH)}$	SCL clock high time	0.6		0.26		
$t_{su(SDA)}$	SDA setup time	100		50		ns
$t_{h(SDA)}$	SDA data hold time	0	0.9	0		µs
$t_{h(ST)}$	START/REPEATED START condition hold time	0.6		0.26		
$t_{su(SR)}$	REPEATED START condition setup time	0.6		0.26		
$t_{su(SP)}$	STOP condition setup time	0.6		0.26		
$t_{w(SP:SR)}$	Bus free time between STOP and START condition	1.3		0.5		
	Data valid time		0.9		0.45	
	Data valid acknowledge time		0.9		0.45	
C_B	Capacitive load for each bus line		400		550	pF

1. *Data based on standard I²C protocol requirement, not tested in production.*
2. *Data for I²C fast mode and I²C fast mode plus have been validated by characterization, not tested in production.*

Figure 9. I²C slave timing diagram



Note: Measurement points are done at 0.3·Vdd_IO and 0.7·Vdd_IO for both ports.

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4.5 Absolute maximum ratings

Stresses above those listed as “absolute maximum ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device under these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

Table 9. Absolute maximum ratings

Symbol	Ratings	Maximum value	Unit
Vdd	Supply voltage	-0.3 to 4.8	V
T_{STG}	Storage temperature range	-40 to +125	°C
Sg	Acceleration *g* for 0.2 ms	20,000	*g*
ESD	Electrostatic discharge protection (HBM)	2	kV
Vin	Input voltage on any control pin (including CS, SCL/SPC, SDA/SDI/SDO, SDO/SA0)	-0.3 to Vdd_IO +0.3	V

Note: Supply voltage on any pin should never exceed 4.8 V.



This device is sensitive to mechanical shock, improper handling can cause permanent damage to the part.



This device is sensitive to electrostatic discharge (ESD), improper handling can cause permanent damage to the part.

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4.6 Terminology

4.6.1 Sensitivity

Linear acceleration sensitivity can be determined, for example, by applying 1 *g* acceleration to the device. Because the sensor can measure DC accelerations, this can be done easily by pointing the selected axis towards the ground, noting the output value, rotating the sensor 180 degrees (pointing towards the sky) and noting the output value again. By doing so, ±1 *g* acceleration is applied to the sensor. Subtracting the larger output value from the smaller one, and dividing the result by 2, leads to the actual sensitivity of the sensor. This value changes very little over temperature and over time. The sensitivity tolerance describes the range of sensitivities of a large number of sensors (see Table 3).

An angular rate gyroscope is a device that produces a positive-going digital output for counterclockwise rotation around the axis considered. Sensitivity describes the gain of the sensor and can be determined by applying a defined angular velocity to it. This value changes very little over temperature and time (see Table 3).

4.6.2 Zero-*g* and zero-rate level

Linear acceleration zero-*g* level offset (TyOff) describes the deviation of an actual output signal from the ideal output signal if no acceleration is present. A sensor in a steady state on a horizontal surface measures 0 *g* on both the X-axis and Y-axis, whereas the Z-axis measures 1 *g*. Ideally, the output is in the middle of the dynamic range of the sensor (content of OUT registers 00h, data expressed as two's complement number). A deviation from the ideal value in this case is called zero-*g* offset.

Offset is to some extent a result of stress to the MEMS sensor and therefore the offset can slightly change after mounting the sensor onto a printed circuit board or exposing it to extensive mechanical stress. Offset changes little over temperature, see “Linear acceleration zero-*g* level change vs. temperature” in Table 3. The zero-*g* level tolerance (TyOff) describes the standard deviation of the range of zero-*g* levels of a group of sensors.

Zero-rate level describes the actual output signal if there is no angular rate present. The zero-rate level of precise MEMS sensors is, to some extent, a result of stress to the sensor and therefore the zero-rate level can slightly change after mounting the sensor onto a printed circuit board or after exposing it to extensive mechanical stress. This value changes very little over temperature and time (see Table 3).

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5 Digital interfaces

5.1 I²C/SPI interface

The registers embedded inside the LSM6DSV16X may be accessed through both the I²C and SPI serial interfaces. The latter may be software configured to operate either in 3-wire or 4-wire interface mode. The device is compatible with SPI modes 0 and 3.

The serial interfaces are mapped to the same pins. To select/exploit the I²C interface, the CS line must be tied high (that is, connected to Vdd_IO).

Table 10. Serial interface pin description

Pin name	Pin description
CS	Enables SPI I²C/SPI mode selection (1: SPI idle mode / I²C communication enabled; 0: SPI communication mode / I²C disabled)
SCL/SPC	I²C serial clock (SCL) SPI serial port clock (SPC)
SDA/SDI/SDO	I²C serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)
SDO/SA0	SPI serial data output (SDO) I²C less significant bit of the device address

5.1.1 I²C serial interface

The LSM6DSV16X I²C is a bus slave. The I²C is employed to write the data to the registers, whose content can also be read back.

The relevant I²C terminology is provided in the table below.

Table 11. I²C terminology

Term	Description
Transmitter	The device that sends data to the bus
Receiver	The device that receives data from the bus
Master	The device that initiates a transfer, generates clock signals, and terminates a transfer
Slave	The device addressed by the master

There are two signals associated with the I²C bus: the serial clock line (SCL) and the serial data line (SDA). The latter is a bidirectional line used for sending and receiving the data to/from the interface. Both the lines must be connected to Vdd_IO through external pull-up resistors. When the bus is free, both the lines are high.

The I²C interface is implemented with fast mode (400 kHz) I²C standards as well as with fast mode plus (1000 kHz).

In order to disable the I²C block, I2C_I3C_disable = 1 must be written in IF_CFG (03h).

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5.1.2 I²C operation

The transaction on the bus is started through a start (ST) signal. A start condition is defined as a high to low transition on the data line while the SCL line is held high. After this has been transmitted by the master, the bus is considered busy. The next byte of data transmitted after the start condition contains the address of the slave in the first 7 bits and the eighth bit tells whether the master is receiving data from the slave or transmitting data to the slave. When an address is sent, each device in the system compares the first seven bits after a start condition with its address. If they match, the device considers itself addressed by the master.

The slave address (SAD) associated to the LSM6DSV16X is 110101xb. The SDO/SA0 pin can be used to modify the less significant bit of the device address. If the SDO/SA0 pin is connected to the supply voltage, LSb is 1 (address 1101011b); else if the SDO/SA0 pin is connected to ground, the LSb value is 0 (address 1101010b). This solution permits to connect and address two different inertial modules to the same I²C bus.

Data transfer with acknowledge is mandatory. The transmitter must release the SDA line during the acknowledge pulse. The receiver must then pull the data line low so that it remains stable low during the high period of the acknowledge clock pulse. A receiver that has been addressed is obliged to generate an acknowledge after each byte of data received.

The I²C embedded inside the LSM6DSV16X behaves like a slave device and the following protocol must be adhered to. After the start condition (ST) a slave address is sent, once a slave acknowledge (SAK) has been returned, an 8-bit subaddress (SUB) is transmitted. The increment of the address is configured by the CTRL3 (12h) (IF_INC).

The slave address is completed with a read/write bit. If the bit is 1 (read), a repeated start (SR) condition must be issued after the two subaddress bytes; if the bit is 0 (write) the master transmits to the slave with direction unchanged. Table 12 explains how the SAD+read/write bit pattern is composed, listing all the possible configurations.

Table 12. SAD+read/write patterns

Command	SAD[6:1]	SAD[0] = SA0	R/W	SAD+R/W
Read	110101	0	1	11010101 (D5h)
Write	110101	0	0	11010100 (D4h)
Read	110101	1	1	11010111 (D7h)
Write	110101	1	0	11010110 (D6h)

Table 13. Transfer when master is writing one byte to slave

Master	ST	SAD + W		SUB		DATA		SP
Slave			SAK		SAK		SAK	

Table 14. Transfer when master is writing multiple bytes to slave

Master	ST	SAD + W		SUB		DATA		DATA		SP
Slave			SAK		SAK		SAK		SAK	

Table 15. Transfer when master is receiving (reading) one byte of data from slave

Master	ST	SAD + W		SUB		SR	SAD + R			NMAK	SP
Slave			SAK		SAK			SAK	DATA		

Table 16. Transfer when master is receiving (reading) multiple bytes of data from slave

Master	ST	SAD+ W		SUB		SR	SAD+ R			MAK		MAK		NMAK	SP
Slave			SAK		SAK			SAK	DATA		DATA		DATA		

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Data are transmitted in byte format (DATA). Each data transfer contains 8 bits. The number of bytes transferred per transfer is unlimited. Data is transferred with the most significant bit (MSb) first. If a slave receiver does not acknowledge the slave address (that is, it is not able to receive because it is performing some real-time function) the data line must be left high by the slave. The master can then abort the transfer. A low to high transition on the SDA line while the SCL line is high is defined as a stop condition. Each data transfer must be terminated by the generation of a stop (SP) condition.

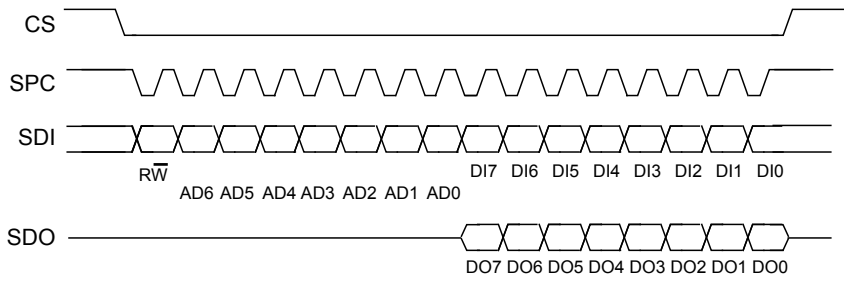
In the presented communication format, MAK is master acknowledge and NMAK is no master acknowledge.

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5.1.3 SPI bus interface

The SPI on the LSM6DSV16X is a bus slave which allows writing and reading the registers of the device.

Figure 10. Read and write protocol (in mode 3)



CS enables the serial port and it is controlled by the SPI master. It goes low at the start of the transmission and goes back high at the end. **SPC** is the serial port clock and it is controlled by the SPI master. It is stopped high when **CS** is high (no transmission). **SDI** and **SDO** are, respectively, the serial port data input and output. Those lines are driven at the falling edge of **SPC** and should be captured at the rising edge of **SPC**.

Both the read register and write register commands are completed in 16 clock pulses or in multiples of 8 in case of multiple read/write bytes. Bit duration is the time between two falling edges of **SPC**. The first bit (bit 0) starts at the first falling edge of **SPC** after the falling edge of **CS** while the last bit (bit 15, bit 23, ...) starts at the last falling edge of SPC just before the rising edge of **CS**.

bit 0: $\overline{RW}$ bit. When 0, the data DI(7:0) is written into the device. When 1, the data DO(7:0) from the device is read. In latter case, the chip drives **SDO** at the start of bit 8.

bit 1-7: address AD(6:0). This is the address field of the indexed register.

bit 8-15: data DI(7:0) (write mode). This is the data that is written into the device (MSb first).

bit 8-15: data DO(7:0) (read mode). This is the data that is read from the device (MSb first).

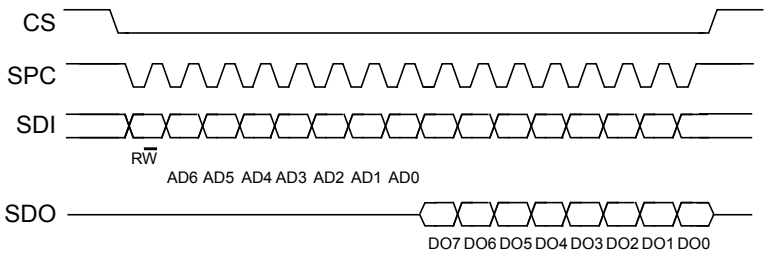
In multiple read/write commands further blocks of 8 clock periods are added. When the CTRL3 (12h) (IF_INC) bit is 0, the address used to read/write data remains the same for every block. When the CTRL3 (12h) (IF_INC) bit is 1, the address used to read/write data is increased at every block.

The function and the behavior of **SDI** and **SDO** remain unchanged.

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5.1.3.1 SPI read

Figure 11. **SPI read protocol (in mode 3)**



The SPI read command is performed with 16 clock pulses. A multiple byte read command is performed by adding blocks of 8 clock pulses to the previous one.

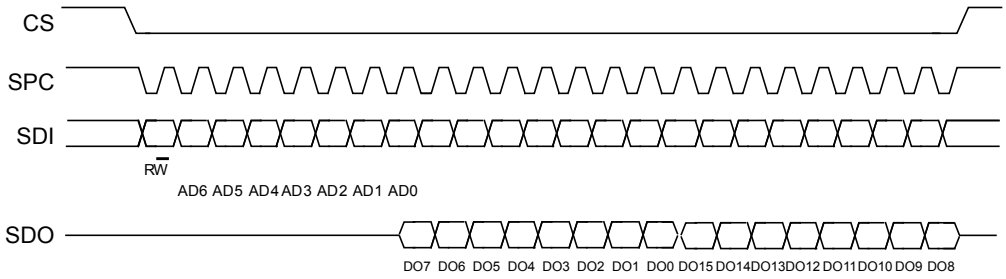
bit 0: READ bit. The value is 1.

bit 1-7: address AD(6:0). This is the address field of the indexed register.

bit 8-15: data DO(7:0) (read mode). This is the data that is read from the device (MSb first).

bit 16-...: data DO(...-8). Further data in multiple byte reads.

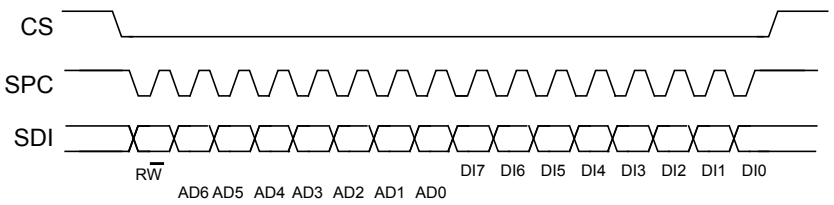
Figure 12. **Multiple byte SPI read protocol (2-byte example) (in mode 3)**



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5.1.3.2 SPI write

Figure 13. SPI write protocol (in mode 3)



The SPI write command is performed with 16 clock pulses. A multiple byte write command is performed by adding blocks of 8 clock pulses to the previous one.

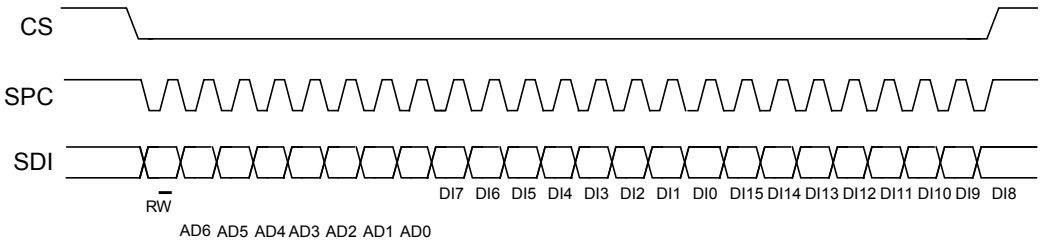
bit 0: WRITE bit. The value is 0.

bit 1 -7: address AD(6:0). This is the address field of the indexed register.

bit 8-15: data DI(7:0) (write mode). This is the data that is written inside the device (MSb first).

bit 16-... : data DI(...-8). Further data in multiple byte writes.

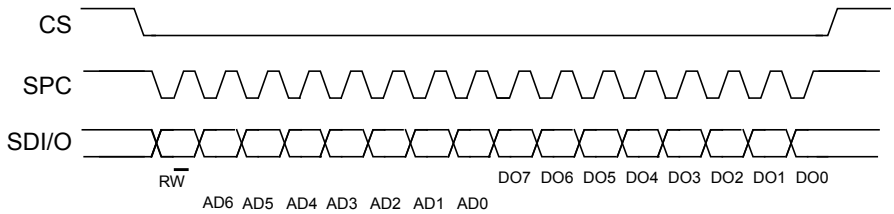
Figure 14. Multiple byte SPI write protocol (2-byte example) (in mode 3)



5.1.3.3 SPI read in 3-wire mode

3-wire mode is entered by setting the IF_CFG (03h) (SIM) bit equal to 1 (SPI serial interface mode selection).

Figure 15. SPI read protocol in 3-wire mode (in mode 3)



The SPI read command is performed with 16 clock pulses:

bit 0: READ bit. The value is 1.

bit 1-7: address AD(6:0). This is the address field of the indexed register.

bit 8-15: data DO(7:0) (read mode). This is the data that is read from the device (MSb first).

A multiple read command is also available in 3-wire mode.

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5.2 MIPI I3C® interface

5.2.1 MIPI I3C® slave interface

The LSM6DSV16X interface includes an MIPI I3C® SDR only slave interface (compliant with release 1.1 of the specification) with MIPI I3C® SDR embedded features:

- CCC command
- Direct CCC communication (SET and GET)
- Broadcast CCC communication
- Private communications
- Private read and write for single byte
- Multiple read and write
- In-band interrupt request
- Slave reset pattern
- Group address
- Full range Vdd_IO support
- Asynchronous modes 0 and 1
- Synchronous mode
- Error detection and recovery methods (S0-S6)

In order to disable the MIPI I3C® block, I2C_I3C_disable = 1 must be written in IF_CFG (03h).

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5.2.2 MIPI I3C® CCC supported commands

The list of MIPI I3C® CCC commands supported by the device is detailed in the following table.

Table 17. **MIPI I3C® CCC commands**

Command	Command code	Default	Description
ENTDAA	0x07		DAA procedure
SETDASA	0x87		Assign dynamic address using static address 0x6B/0x6A depending on SDO pin
ENEC	0x80 / 0x00		Slave activity control (direct and broadcast)
DISEC	0x81/ 0x01		Slave activity control (direct and broadcast)
ENTAS0	0x82 / 0x02		Enter activity state (direct and broadcast)
SETXTIME	0x98 / 0x28		Timing information exchange
GETXTIME	0x99	0x07 0x00 0x05 0x92	Timing information exchange
RSTDAA	0x06		Reset the assigned dynamic address (broadcast only)
SETMWL	0x89 / 0x08		Define maximum write length during private write (direct and broadcast)
SETMRL	0x8A / 0x09		Define maximum read length during private read (direct and broadcast)
SETNEWDA	0x88		Change dynamic address
GETMWL	0x8B	0x00 0x08 (2 byte)	Get maximum write length during private write
GETMRL	0x8C	0x00 0x10 0x09 (3 byte)	Get maximum read length during private read
GETPID	0x8D	0x02 0x08 0x00 0x70 0x92 0x0B	SDO = 1
		0x02 0x08 0x00 0x70 0x12 0x0B	SDO = 0
GETBCR	0x8E	0x07 (1 byte)	Bus characteristics register
GETDCR	0x8F	0x44 default	MIPI I3C® device characteristics register
GETSTATUS	0x90	0x00 0x00 (2 byte)	Status register

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Command	Command code	Default	Description
GETMXDS	0x94	0x08 0x60	Return max write and read speed
GETCAPS	0x95	0x00 0x11 0x18 0x00	Provide information about device capabilities and supported extended features
SETGRPA	0x9B		Group address assignment command
RSTGRPA	0x2C / 0x9C		Reset the group address
RSTACT	0x9A / 0x2A		Configure slave reset action

5.2.3 Overview of anti-spike filter management

The device acts as a standard I²C target as long as it has an I²C static address. The device is capable of detecting and disabling the I²C anti-spike filter after detecting the broadcast address (7'h7E/W). In order to guarantee proper behavior of the device, the I3C master must emit the first START, 7'h7E/W at open-drain speed using I²C fast mode plus reference timing.

After detecting the broadcast address, the device can receive the I3C dynamic address following the I3C push-pull timing. If the device is not assigned a dynamic address, then the device continues to operate as an I²C device with no anti-spike filter. For the case in which the host decides to keep the device as I²C with anti-spike filter, there is a configuration required to keep the anti-spike filter active. This configuration is done by writing the ASF_CTRL bit to 1 in the IF_CFG (03h) register. This configuration forces the anti-spike filter to always be turned on instead of being managed by the communication on the bus.

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5.3 Master I²C interface

If the LSM6DSV16X is configured in mode 2, a master I²C line is available. The master serial interface is mapped to the following dedicated pins.

Table 18. Master I²C pin details

Pin name	Pin description
MSCL	I²C serial clock master
MSDA	I²C serial data master
MDRDY	I²C master external synchronization signal

5.4 Auxiliary SPI interface

If the LSM6DSV16X is configured in mode 3, the auxiliary SPI is available. The auxiliary SPI interface is mapped to the following dedicated pins.

Table 19. Auxiliary SPI pin details

Pin name	Pin description
OCS_Aux	Enables auxiliary SPI 3/4-wire
SDx/AH1/Qvar1	Auxiliary SPI 3/4-wire data input (SDI_Aux) and SPI 3-wire data output (SDO_Aux)
SCx/AH2/Qvar2	Auxiliary SPI 3/4-wire interface serial port clock
SDO_Aux	Auxiliary SPI 4-wire data output (SDO_Aux)

When the LSM6DSV16X is configured in mode 3, the auxiliary SPI can be connected to a camera module for OIS support.

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6 Functionality

This section describes all the operating modes and power modes of the LSM6DSV16X.

Note: Refer to the product application note for the details regarding operating/power mode configurations, settings, turn-on/off time and on-the-fly changes.

6.1 Operating modes

In the LSM6DSV16X, the accelerometer and the gyroscope can be turned on/off independently of each other and are allowed to have different ODRs and power modes.

The LSM6DSV16X has three operating modes available:

- Only accelerometer active and gyroscope in power-down
- Only gyroscope active and accelerometer in power-down
- Both accelerometer and gyroscope sensors active with independent ODR and power mode

The accelerometer is activated from power-down by writing ODR_XL_[3:0] in CTRL1 (10h) while the gyroscope is activated from power-down by writing ODR_G_[3:0] in CTRL2 (11h). For combo mode, the ODRs are totally independent.

6.2 Accelerometer power modes

In the LSM6DSV16X, the accelerometer can be configured in five different operating modes: power-down mode, low-power mode (1, 2, 3), normal mode, high-performance mode and high-accuracy ODR mode.

The operating mode selected depends on the value of the OP_MODE_XL_[2:0] bits in CTRL1 (10h).

If the value of the OP_MODE_XL_[2:0] bits is 000 (default), high-performance mode is valid for all ODRs (from 7.5 Hz up to 7.68 kHz).

Normal mode is available for ODR values from 7.5 Hz to 1.92 kHz and it is enabled by setting the OP_MODE_XL_[2:0] bits to 111. Normal mode cannot be used in mode 3 connection mode.

In high-performance mode and in normal mode the analog anti-aliasing filter is active.

Low-power mode is available for lower ODRs (1.875 Hz, 15 Hz, 30 Hz, 60 Hz, 120 Hz, 240 Hz). The three low-power modes are enabled by setting OP_MODE_XL_[2:0] to 100 (LPM1), 101 (LPM2), 110 (LPM3).

High-accuracy ODR mode is available for ODR values from 15 Hz up to 7.68 kHz and it is enabled by setting the OP_MODE_XL_[2:0] bits to 001. Refer to Section 6.5 High-accuracy ODR mode for more details.

The embedded functions based on accelerometer data (free-fall, 6D/4D, tap/double-tap, wake-up, activity/inactivity, stationary/motion, step counter, step detection, significant motion, tilt) and the FIFO batching functionality are supported in all modes.

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6.3 Accelerometer dual-channel mode

The LSM6DSV16X accelerometer block has a dual-channel architecture able to work with two different full scales simultaneously. By default, the device operates in single-channel mode supporting FS scale values from ±2 *g* through ±16 *g* and different power modes, as described in Section 6.2 Accelerometer power modes. The block diagrams in the following figures show the configuration of acceleration data processing in the two different modes.

Figure 16. Single-channel mode (XL_DualC_EN = 0)

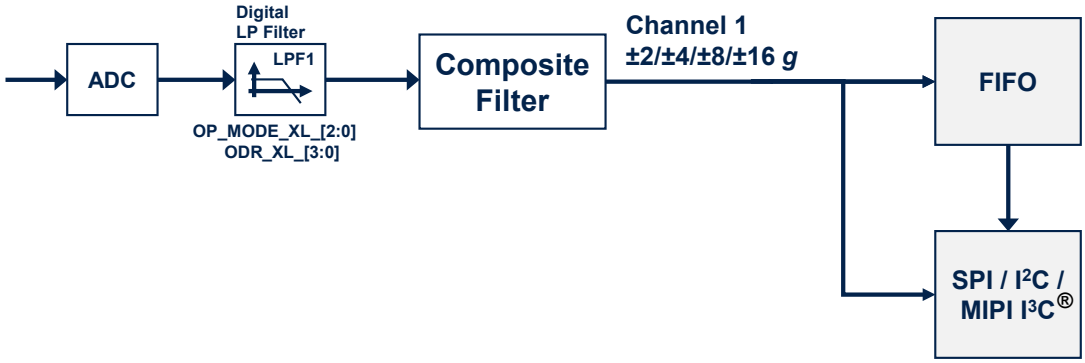
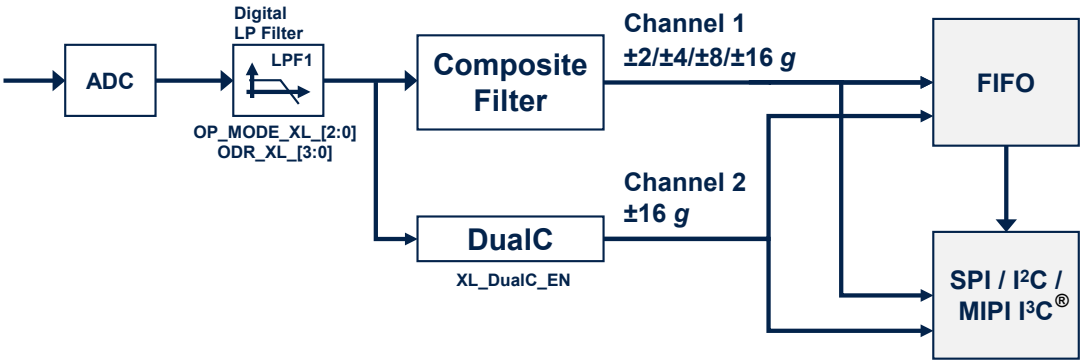


Figure 17. Dual-channel mode (XL_DualC_EN = 1)



The dual-channel functionality can be enabled/disabled by configuring the bit XL_DualC_EN to 1 (enable) or to 0 (disable) in CTRL8 (17h).

Referring to Figure 17. Dual-channel mode (XL_DualC_EN = 1), when the dual-channel mode has been activated:

1. Channel 1 supports user-selectable full-scale acceleration range of ±2/±4/±8/±16 *g* based on the value of the FS_XL_[1:0] bits in the CTRL8 (17h) register.
2. Channel 2 full scale is set to ±16 *g*. Acceleration data are available in the output registers from UI_OUTX_L_A_OIS_DualC (34h) and UI_OUTX_H_A_OIS_DualC (35h) through UI_OUTZ_L_A_OIS_DualC (38h) and UI_OUTZ_H_A_OIS_DualC (39h)).

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6.4 Gyroscope power modes

In the LSM6DSV16X, the gyroscope can be configured in five different operating modes: power-down mode, sleep mode, low-power mode, high-performance mode and high-accuracy ODR mode.

The operating mode selected depends on the value of the OP_MODE_G_[2:0] bits in CTRL2 (11h).

If the value of the OP_MODE_G_[2:0] bits is 000 (default), high-performance mode is valid for all ODRs (from 7.5 Hz up to 7.68 kHz).

Low-power mode is available for lower ODRs (7.5 Hz, 15 Hz, 30 Hz, 60 Hz, 120 Hz, 240 Hz) and it is enabled by setting the the OP_MODE_G_[2:0] bits to 101.

High-accuracy ODR mode is available for ODR values from 15 Hz up to 7.68 kHz and it is enabled by setting the OP_MODE_G_[2:0] bits to 001. Refer to Section 6.5 High-accuracy ODR mode for more details.

6.5 High-accuracy ODR mode

High-accuracy ODR (HAODR) mode can be enabled to reduce the part-to-part output data rate variation. It supports accelerometer only, gyroscope only, and combo (accelerometer and gyroscope) modes. When this mode is used for one sensor (accelerometer or gyroscope), the other sensor also has to be configured in high-accuracy ODR (HAODR) mode.

The main high-accuracy ODR features are:

- Noise level is aligned with high-performance mode
- Power consumption increase of 20 µA (typical) vs. the corresponding high-performance mode configuration selected
- The UI channel bandwidth can be selected through the gyroscope LPF1 and accelerometer HPF/LPF2 filters.
- When HAODR mode is enabled, it is applied to the UI accelerometer, UI gyroscope, EIS gyroscope, and temperature. It is not applied to OIS accelerometer/gyroscope channels.

Note: HAODR mode has to be enabled / disabled when the device is in power-down mode.

When HAODR mode is enabled, two different sets of ODRs are supported based on the configuration of the HAODR_SEL_[1:0] bitfield in the HAODR_CFG (62h) register, as shown in the table below.

Note: High-accuracy ODR mode is not compatible with the analog hub / Qvar functionality and the activity/inactivity functionality (motion/stationary can be used).

Table 20. Accelerometer and gyroscope ODR selection in high-accuracy ODR mode

ODR_XL_[3:0] ODR_G_[3:0]	ODR [Hz] HAODR_SEL_[1:0] = 00	ODR [Hz] HAODR_SEL_[1:0] = 01	ODR [Hz] HAODR_SEL_[1:0] = 10
0000	Power-down	Power-down	Power-down
0001	Reserved	Reserved	Reserved
0010	Reserved	Reserved	Reserved
0011	15	15.625	12.5
0100	30	31.25	25
0101	60	62.5	50
0110	120	125	100
0111	240	250	200
1000	480	500	400
1001	960	1000	800
1010	1920	2000	1600
1011	3840	4000	3200
1100	7680	8000	6400
Others	Reserved	Reserved	Reserved

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6.6 ODR-triggered mode

When ODR-triggered mode is enabled, a reference signal must be provided to the INT2 pin, and the device then automatically aligns (in frequency and phase) the data generation to the edges of the reference signal.

It supports accelerometer only, gyroscope only, and combo (accelerometer and gyroscope) modes. When both the accelerometer and gyroscope are enabled, the user must configure the same ODR on both the accelerometer and gyroscope. It is not possible to select different ODRs for the accelerometer and gyroscope; if different output data rate values are set, the ODR configured for the gyroscope data is also applied to the accelerometer data.

The full-scale configurations are totally independent between the accelerometer and gyroscope and they can be set in any combination.

Note: ODR-triggered mode has to be enabled / disabled when the device is in power-down mode.

Note: When ODR-triggered mode is enabled, the 1100 configuration of the ODR_XL_[3:0] bits in register CTRL1 (10h) and the 1100 configuration of the ODR_G_[3:0] bits in register CTRL2 (11h) cannot be used.

Note: ODR-triggered mode is not compatible with the analog hub / Qvar functionality nor the EIS functionality.

6.7 Analog hub functionality

The LSM6DSV16X embeds an analog hub sensing functionality which is able to connect an analog input and convert it to a digital signal for embedded processing.

In the LSM6DSV16X, the analog hub has a dedicated channel that can be activated by setting the AH_QVAR_EN bit to 1 in the CTRL7 (16h) register.

The accelerometer sensor must be set in high-performance mode or in normal mode when the analog hub channel is enabled.

The analog hub data-ready signal is represented by the AH_QVARDA bit of the STATUS_REG (1Eh) register. This signal can be driven to the INT2 pin by setting the INT2_DRDY_AH_QVAR bit to 1 in the CTRL7 (16h) register.

Analog hub data are available as a 16-bit word in two's complement in the AH_QVAR_OUT_L (3Ah) and AH_QVAR_OUT_H (3Bh) registers at a fixed rate of 240 Hz (typical).

Analog signal data can be also processed by MLC/FSM logic.

The analog hub functionality is available in mode 1 connection mode for the I²C interface only. The external analog lines have to be connected to pin 2 (SDx/AH1/Qvar1) and/or pin 3 (SCx/AH2/Qvar2), so the I²C-master interface (mode 2) and the auxiliary SPI (mode 3) are not available when the analog hub is used.

The equivalent input impedance of the analog hub buffers can be selected by properly setting the AH_QVAR_C_ZIN_[1:0] bits in the CTRL7 (16h) register.

6.8 Qvar functionality

The LSM6DSV16X embeds a Qvar sensor which is able to detect electric charge variations in the proximity of the external electrodes connected to the device.

In the LSM6DSV16X, Qvar has a dedicated channel that can be activated by setting the AH_QVAR_EN bit to 1 in the CTRL7 (16h) register.

The accelerometer sensor must be set in high-performance mode or in normal mode when the Qvar channel is enabled.

The Qvar data-ready signal is represented by the AH_QVARDA bit of the STATUS_REG (1Eh) register. This signal can be driven to the INT2 pin by setting the INT2_DRDY_AH_QVAR bit to 1 in the CTRL7 (16h) register.

Qvar data are available as a 16-bit word in two's complement in the AH_QVAR_OUT_L (3Ah) and AH_QVAR_OUT_H (3Bh) registers at a fixed rate of 240 Hz (typical).

Qvar data can also be processed by MLC/FSM logic.

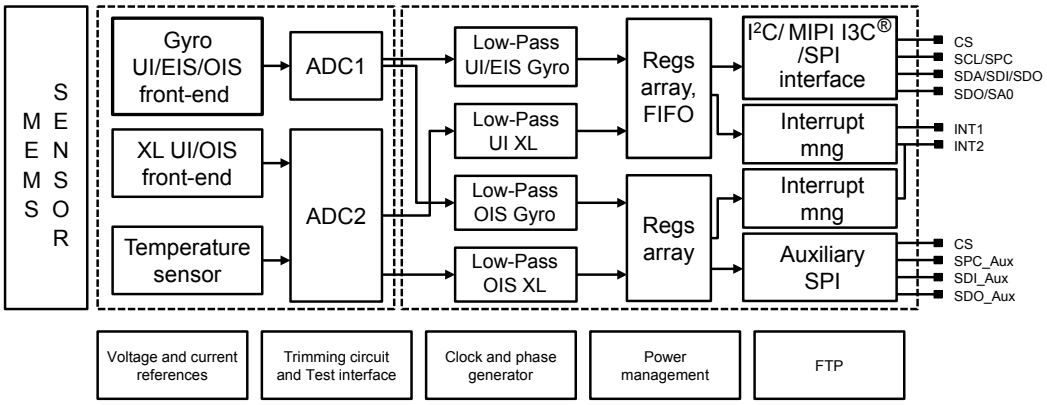
The Qvar functionality is available in mode 1 connection mode for the I²C interface only. The external electrodes have to be connected to pin 2 (SDx/AH1/Qvar1) and/or pin 3 (SCx/AH2/Qvar2), so the I²C-master interface (mode 2) and the auxiliary SPI (mode 3) are not available when Qvar is used.

The equivalent input impedance of the Qvar buffers can be selected by properly setting the AH_QVAR_C_ZIN_[1:0] bits in the CTRL7 (16h) register.

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6.9 Block diagram of filters

Figure 18. **Block diagram of filters**



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6.9.1 Block diagrams of the accelerometer filters

In the LSM6DSV16X, the filtering chain for the accelerometer part is composed of the following:

- Digital filter (LPF1)
- Composite filter

Details of the block diagram appear in the following figure.

Figure 19. Accelerometer UI chain

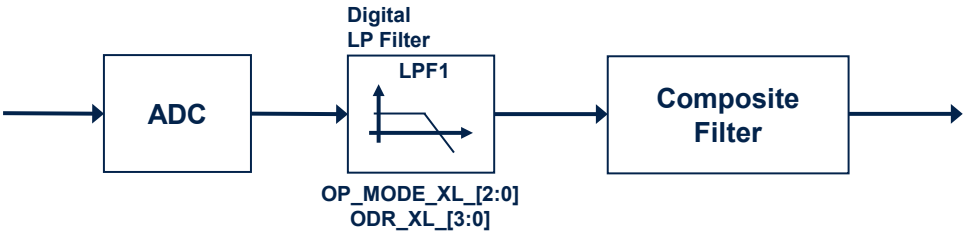
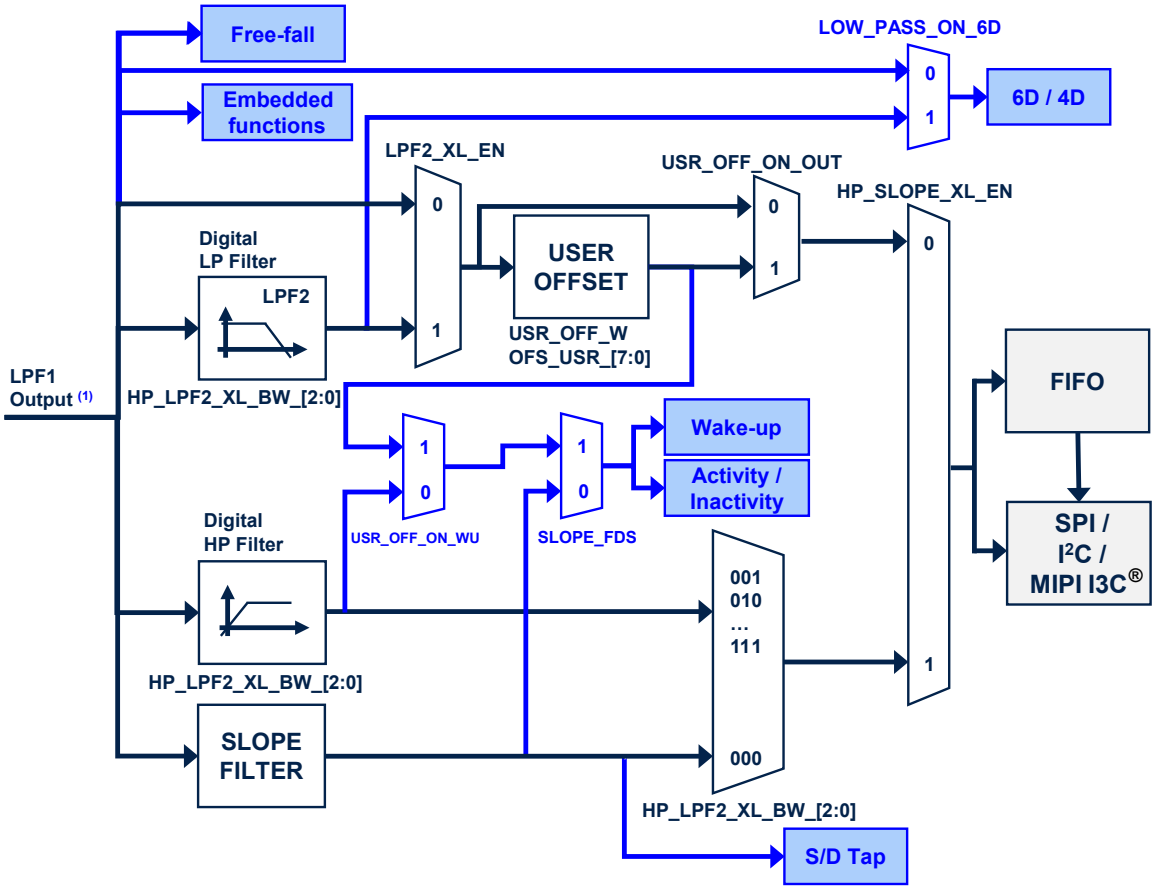


Figure 20. Accelerometer composite filter



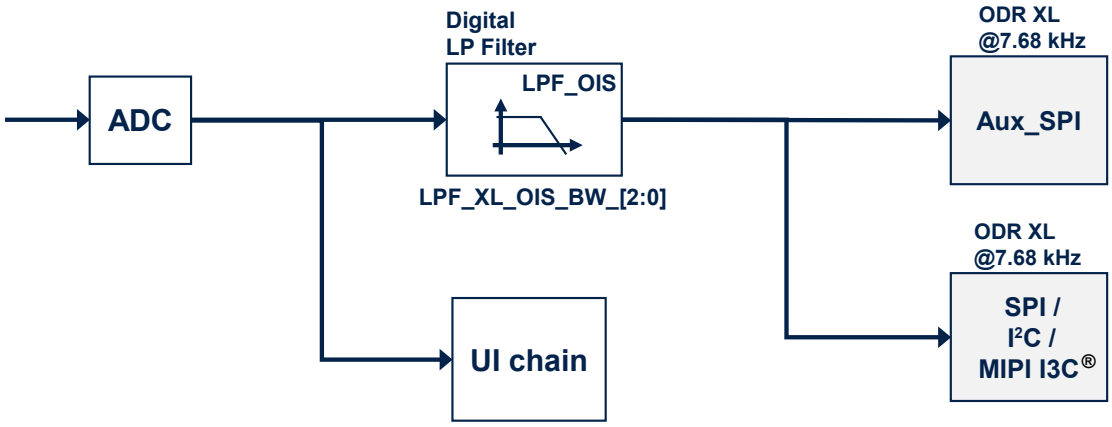
1. *The cutoff value of the LPF1 output is ODR/2 when the accelerometer is in high-performance mode, high-accuracy ODR mode, or normal mode. This value is equal to 2300 Hz when the accelerometer is in low-power mode 1 (2 mean), 912 Hz in low-power mode 2 (4 mean) or 431 Hz in low-power mode 3 (8 mean).*

Note: Embedded functions include finite state machine, machine learning core, pedometer, step detector and step counter, significant motion detection, and tilt functions.

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The accelerometer filtering chain when mode 3 is enabled is illustrated in the following figure.

Figure 21. Accelerometer chain with mode 3 enabled



Note: The accelerometer OIS chain is enabled by setting the OIS_XL_EN bit to 1 in the UI_CTRL1_OIS (70h) / SPI2_CTRL1_OIS (70h) register.

The configuration of the accelerometer UI chain is not affected by enabling/disabling the accelerometer OIS chain, with one exception: accelerometer normal operating mode (OP_MODE_XL_[2:0] = 111 in the CTRL1 (10h) register) cannot be used when the accelerometer OIS chain is enabled.

Accelerometer output values are available in the following registers with ODR at 7.68 kHz:

- UI_OUTX_L_A_OIS_DualC (34h) and UI_OUTX_H_A_OIS_DualC (35h) through UI_OUTZ_L_A_OIS_DualC (38h) and UI_OUTZ_H_A_OIS_DualC (39h)
- SPI2_OUTX_L_A_OIS (28h) and SPI2_OUTX_H_A_OIS (29h) through SPI2_OUTZ_L_A_OIS (2Ch) and SPI2_OUTZ_H_A_OIS (2Dh)

Note: When the accelerometer OIS is used, refer to the product application note for the power mode configuration and settings.

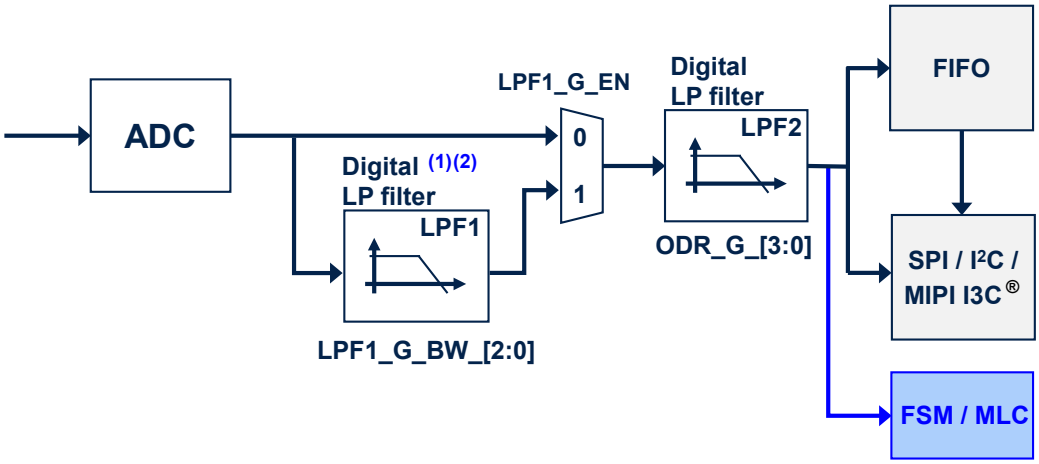
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6.9.2 Block diagrams of the gyroscope filters

In the LSM6DSV16X, the gyroscope filtering chain depends on the mode configuration:

- Mode 1 (for user interface (UI) and electronic image stabilization (EIS) functionality through the primary interface) and mode 2

Figure 22. Gyroscope digital chain - mode 1 (UI/EIS) and mode 2



1. *When the gyroscope OIS or EIS chain is enabled, the LPF1 filter is not available in the gyroscope UI chain. It is recommended to avoid using the LPF1 filter in the gyroscope UI chain when the gyroscope OIS or EIS is used.*
2. *The LPF1 filter is available in high-performance mode only. If the gyroscope is configured in low-power mode, the LPF1 filter is bypassed.*

In this configuration, the gyroscope ODR is selectable from 7.5 Hz up to 7.68 kHz. A low-pass filter (LPF1) is available, for more details about the filter characteristics see Table 64. Gyroscope LPF1 + LPF2 bandwidth selection.

The digital LPF2 filter's cutoff frequency depends on the selected gyroscope ODR, as indicated in the following table.

Table 21. Gyroscope LPF2 bandwidth selection

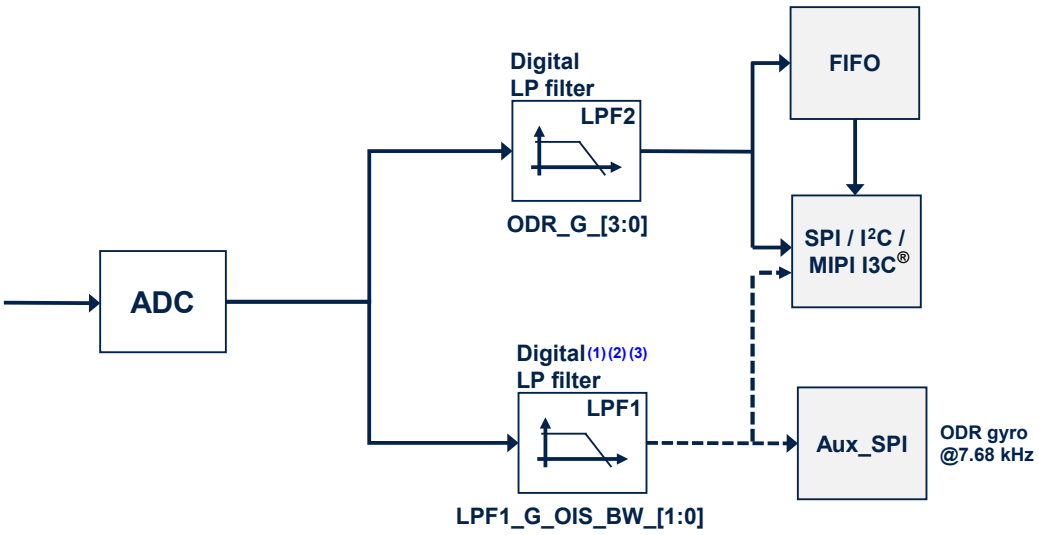
Gyroscope ODR [Hz]	LPF2 cutoff [Hz]
7.5	3.4
15	6.6
30	13.0
60	24.6
120	49.4
240	96
480	187
960	342
1.92 kHz	491
3.84 kHz	528
7.68 kHz	537

Note: Data can be acquired from the output registers and FIFO over the primary I²C/MIPI I3C®/SPI interface.

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- Mode 3 (for OIS functionality)

Figure 23. Gyroscope digital chain - mode 3 (OIS)



1. *When the gyroscope OIS or EIS chain is enabled, the LPF1 filter is not available in the gyroscope UI chain.*
2. *It is recommended to avoid using the LPF1 filter in mode1/2 when the gyroscope OIS or EIS chain is used.*
3. *When the gyroscope OIS is used, refer to the product application note for the power mode configuration and settings.*

The auxiliary interface needs to be enabled in UI_CTRL1_OIS (70h) / SPI2_CTRL1_OIS (70h).

In mode 3 configuration, there are two paths:

- The chain for user interface (UI) where the ODR is selectable from 7.5 Hz up to 7.68 kHz
- The chain for OIS where the ODR is at 7.68 kHz and the LPF1 is available. The LPF1 configuration depends on the setting of the LPF1_G_OIS_BW_[1:0] bits in register UI_CTRL2_OIS (71h) / SPI2_CTRL2_OIS (71h); for more details about the filter characteristics see UI_CTRL2_OIS (71h). Gyroscope output values are in registers 22h to 27h if read from the Auxi_SPI or in registers 2Eh to 33h if read from the primary interface with the selected full scale FS_G_OIS_[1:0] bits in UI_CTRL2_OIS (71h) / SPI2_CTRL2_OIS (71h)).

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6.10 Enhanced EIS

The LSM6DSV16X offers advanced design flexibility for EIS applications: enhanced EIS functionality has a dedicated channel and processing with independent filtering.

Enhanced EIS main features:

- Enhanced EIS channel gyroscope data can be read over the primary interfaces through I²C / MIPI I3C® / SPI.
- EIS data are available in free-run mode in the output registers (UI_OUTX_L_G_OIS_EIS (2Eh) and UI_OUTX_H_G_OIS_EIS (2Fh) through UI_OUTZ_L_G_OIS_EIS (32h) and UI_OUTZ_H_G_OIS_EIS (33h)) by setting the G_EIS_ON_G_OIS_OUT_REG bit to 1 in the CTRL_EIS (6Bh) register or in FIFO (by setting the G_EIS_FIFO_EN bit to 1 in the FIFO_CTRL4 (0Ah) register) with dedicated TAG and timestamp configurable using FIFO_CTRL4 (0Ah).
- Enhanced EIS option is compatible with mode 3 selection. When EIS data-out are read from the output registers (setting G_EIS_ON_G_OIS_OUT_REG bit), data from the gyroscope OIS chain can be only read from the auxiliary SPI interface.

Figure 24. LSM6DSV16X supports UI, enhanced EIS, and OIS processing simultaneously

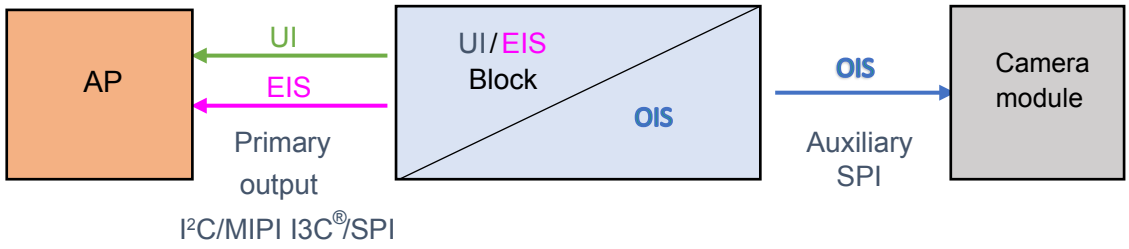
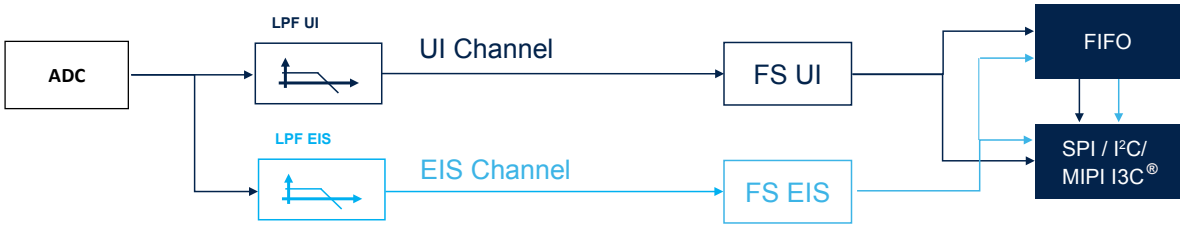


Figure 25. Gyroscope enhanced EIS and UI block diagram



When enhanced EIS mode is activated through the ODR_EIS_[1:0] bits in the CTRL_EIS (6Bh) register:

- Gyroscope UI can be configured only in power-down mode, high-performance mode, or high-accuracy ODR mode.
- Gyroscope EIS full scale can be selected by using the FS_G_EIS_[2:0] bits in the CTRL_EIS (6Bh) register.
- Gyroscope EIS data rate selectable at 1.92 kHz or 960 Hz configurable through the ODR_G_EIS_[1:0] bits in the CTRL_EIS (6Bh) register.
- LPF_EIS low-pass filter (refer to Figure 25) bandwidth selection can be configured through the LPF_G_EIS_BW bit in the CTRL_EIS (6Bh) register.

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6.11 OIS

This section describes OIS functionality. There is a dedicated gyroscope and accelerometer DSP for OIS.
The device also supports self-test functionality on the OIS side.

6.11.1 Enabling OIS functionality and connection schemes

There are two different ways in order to enable and configure OIS functionality:

- **Auxiliary SPI full control**: Enabling and configuration done from the auxiliary SPI
- **Primary interface full control**: Enabling and configuration done from the primary interface

The configurations that allow selecting these two different options are done using the OIS_CTRL_FROM_UI bit in the FUNC_CFG_ACCESS (01h) register as described in the following table.

Table 22. OIS configurations

OIS_CTRL_FROM_UI	OIS configuration option
0	Auxiliary SPI full control
1	Primary interface full control

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6.11.1.1 *Auxiliary SPI full control*

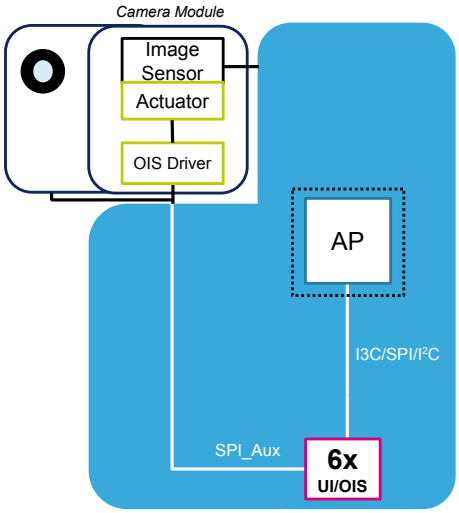
This is the default condition of the device. The camera module is completely independent from the application processor as shown in Figure 26.

The auxiliary SPI can configure OIS functionality through SPI2_INT_OIS (6Fh), SPI2_CTRL1_OIS (70h), SPI2_CTRL2_OIS (71h), SPI2_CTRL3_OIS (72h).

Reading from the auxiliary SPI is enabled only when the SPI2_READ_EN bit in the SPI2_CTRL1_OIS (70h) register is set to 1.

The primary interface can access the OIS control registers (UI_INT_OIS (6Fh), UI_CTRL1_OIS (70h), UI_CTRL2_OIS (71h), UI_CTRL3_OIS (72h)) in read mode.

Figure 26. Auxiliary SPI full control



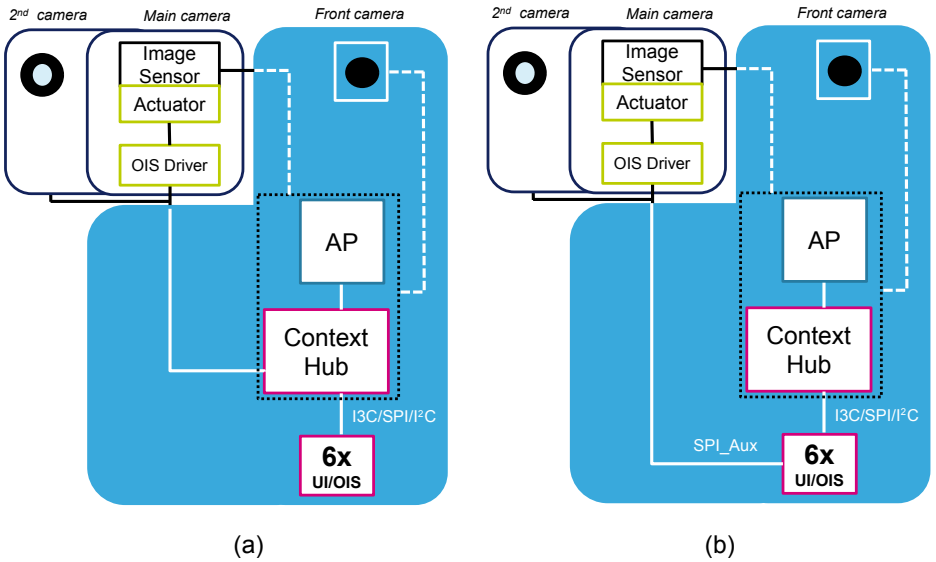
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6.11.1.2 *Primary interface full control*

This option allows the application processor to configure all OIS functionalities from the primary interface. This option allows using embedded OIS data for both the main and front camera, connecting them to the application processor (eventually adding a context hub) as shown in Figure 27: the AP can also do some processing on the data before sending them to the cameras.

In order to place the device in this mode, the OIS_CTRL_FROM_UI bit in the FUNC_CFG_ACCESS (01h) register must be set to 1 from the primary interface.

Figure 27. OIS Primary interface full control



Then, the AP can configure OIS functionalities through UI_INT_OIS (6Fh), UI_CTRL1_OIS (70h), UI_CTRL2_OIS (71h), UI_CTRL3_OIS (72h).

Reading from the auxiliary SPI can be enabled by setting the SPI2_ READ_EN bit in the UI_CTRL1_OIS (70h) register to 1 in order to directly read OIS data (as shown in Figure 27 (b)). The auxiliary SPI can access the SPI2_INT_OIS (6Fh), SPI2_CTRL1_OIS (70h), SPI2_CTRL2_OIS (71h), and SPI2_CTRL3_OIS (72h) registers in read-only mode.

Note: The OIS_CTRL_FROM_UI bit is reset by the software reset procedure.

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6.12 FIFO

The presence of a FIFO allows consistent power saving for the system since the host processor does not need continuously poll data from the sensor, but It can wake up only when needed and burst the significant data out from the FIFO.

The LSM6DSV16X embeds 1.5 KB of data in FIFO (up to 4.5 KB with the compression feature enabled) to store the following data:

- Gyroscope
- Accelerometer
- External sensors (up to 4)
- Step counter
- Timestamp
- Temperature
- MLC features and filters
- SFLP output data (quaternion, gyroscope bias, gravity vector)

Writing data in the FIFO can be configured to be triggered by the:

- Accelerometer / gyroscope data-ready signal
- Sensor hub data-ready signal
- Step detection signal

The applications have maximum flexibility in choosing the rate of batching for physical sensors with FIFO-dedicated configurations: accelerometer, gyroscope and temperature sensor batch rates can be selected by the user. External sensor writing in FIFO can be triggered by the accelerometer data-ready signal or by an external sensor interrupt. The step counter can be stored in FIFO with associated timestamp each time a step is detected. It is possible to select decimation for timestamp batching in FIFO with a factor of 1, 8, or 32.

The reconstruction of a FIFO stream is a simple task thanks to the FIFO_DATA_OUT_TAG byte that allows recognizing the meaning of a word in FIFO.

FIFO allows correct reconstruction of the timestamp information for each sensor stored in FIFO. If a change in the ODR or BDR (batch data rate) configuration is performed, the application can correctly reconstruct the timestamp and know exactly when the change was applied without disabling FIFO batching. FIFO stores information of the new configuration and timestamp in which the change was applied in the device.

Finally, FIFO embeds a compression algorithm that the user can enable in order to have up to 4.5 KB data stored in FIFO and take advantage of interface communication length for FIFO flushing and communication power consumption.

The programmable FIFO watermark threshold can be set using the WTM[7:0] bits in the FIFO_CTRL1 (07h) register. To monitor the FIFO status, dedicated registers (FIFO_STATUS1 (1Bh), FIFO_STATUS2 (1Ch)) can be read to detect FIFO overrun events, FIFO full status, FIFO empty status, FIFO watermark status and the number of unread samples stored in the FIFO. To generate dedicated interrupts on the INT1 and INT2 pins of these status events, the configuration can be set in INT1_CTRL (0Dh) and INT2_CTRL (0Eh).

The FIFO buffer can be configured according to seven different modes:

- Bypass mode
- FIFO mode
- Continuous mode
- Continuous-to-FIFO mode
- ContinuousWTM-to-full mode
- Bypass-to-continuous mode
- Bypass-to-FIFO mode

Each mode is selected by the FIFO_MODE_[2:0] bits in the FIFO_CTRL4 (0Ah) register.

6.12.1 Bypass mode

In bypass mode (FIFO_CTRL4 (0Ah)(FIFO_MODE_[2:0] = 000), the FIFO is not operational and it remains empty. Bypass mode is also used to reset the FIFO when in FIFO mode.

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6.12.2 FIFO mode

In FIFO mode (FIFO_CTRL4 (0Ah)(FIFO_MODE_[2:0] = 001) data from the output channels are stored in the FIFO until it is full.

To reset FIFO content, bypass mode should be selected by writing FIFO_CTRL4 (0Ah)(FIFO_MODE_[2:0]) to 000. After this reset command, it is possible to restart FIFO mode by writing FIFO_CTRL4 (0Ah) (FIFO_MODE_[2:0]) to 001.

The FIFO buffer memorizes up to 4.5 KB of data (with compression enabled) but the depth of the FIFO can be resized by setting the WTM[7:0] bits in FIFO_CTRL1 (07h). If the STOP_ON_WTM bit in FIFO_CTRL2 (08h) is set to 1, FIFO depth is limited up to the WTM[7:0] bits in the FIFO_CTRL1 (07h) register.

6.12.3 Continuous mode

Continuous mode (FIFO_CTRL4 (0Ah)(FIFO_MODE_[2:0] = 110) provides a continuous FIFO update: as new data arrives, the older data is discarded.

A FIFO threshold flag FIFO_STATUS2 (1Ch)(FIFO_WTM_IA) is asserted when the number of unread samples in FIFO is greater than or equal to FIFO_CTRL1 (07h) (WTM[7:0]).

It is possible to route the FIFO_WTM_IA flag to the INT1 pin by writing in register INT1_CTRL (0Dh) (INT1_FIFO_TH) = 1 or to the INT2 pin by writing in register INT2_CTRL (0Eh)(INT2_FIFO_TH) = 1.

A full-flag interrupt can be enabled, INT1_CTRL (0Dh)(INT1_FIFO_FULL) = 1 or INT2_CTRL (0Eh) (INT2_FIFO_FULL) = 1, in order to indicate FIFO saturation and eventually read its content all at once.

If an overrun occurs, at least one of the oldest samples in FIFO has been overwritten and the FIFO_OVR_IA flag in FIFO_STATUS2 (1Ch) is asserted.

In order to empty the FIFO before it is full, it is also possible to pull from FIFO the number of unread samples available in FIFO_STATUS1 (1Bh) and FIFO_STATUS2 (1Ch)(DIFF_FIFO_[8:0]).

6.12.4 Continuous-to-FIFO mode

In continuous-to-FIFO mode (FIFO_CTRL4 (0Ah)(FIFO_MODE_[2:0] = 011), FIFO behavior changes according to the trigger event detected in one of the following interrupt events:

- Single tap
- Double tap
- Wake-up
- Free-fall
- D6D

When the selected trigger bit is equal to 1, FIFO operates in FIFO mode.

When the selected trigger bit is equal to 0, FIFO operates in continuous mode.

6.12.5 ContinuousWTM-to-full mode

In continuousWTM-to-full mode (FIFO_CTRL4 (0Ah)(FIFO_MODE_[2:0] = 010), FIFO behavior changes according to the trigger event detected in one of the following interrupt events:

- Single tap
- Double tap
- Wake-up
- Free-fall
- D6D

When the selected trigger bit is equal to 0, FIFO operates in continuous mode with the FIFO size limited to the FIFO watermark level (defined by the WTM[7:0] bits in the FIFO_CTRL1 (07h) register).

When the selected trigger bit is equal to 1, FIFO continues to store data until it is full.

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6.12.6 Bypass-to-continuous mode

In bypass-to-continuous mode (FIFO_CTRL4 (0Ah)(FIFO_MODE_[2:0] = 100), data measurement storage inside FIFO operates in Continuous mode when selected triggers are equal to 1, otherwise FIFO content is reset (bypass mode).

FIFO behavior changes according to the trigger event detected in one of the following interrupt events:

- Single tap
- Double tap
- Wake-up
- Free-fall
- D6D

6.12.7 Bypass-to-FIFO mode

In bypass-to-FIFO mode (FIFO_CTRL4 (0Ah)(FIFO_MODE_[2:0] = 111), data measurement storage inside FIFO operates in FIFO mode when selected triggers are equal to 1, otherwise FIFO content is reset (bypass mode).

FIFO behavior changes according to the trigger event detected in one of the following interrupt events:

- Single tap
- Double tap
- Wake-up
- Free-fall
- D6D

6.12.8 FIFO reading procedure

The data stored in FIFO are accessible from dedicated registers and each FIFO word is composed of 7 bytes: one tag byte (FIFO_DATA_OUT_TAG (78h), in order to identify the sensor, and 6 bytes of fixed data (FIFO_DATA_OUT registers from (79h) to (7Eh)).

The DIFF_FIFO_[8:0] field in the FIFO_STATUS1 (1Bh) and FIFO_STATUS2 (1Ch) registers contains the number of words (1 byte TAG + 6 bytes DATA) collected in FIFO.

In addition, it is possible to configure a counter of the batch events of accelerometer or gyroscope sensors. The flag COUNTER_BDR_IA in FIFO_STATUS2 (1Ch) alerts that the counter reaches a selectable threshold (CNT_BDR_TH_[9:0] field in COUNTER_BDR_REG1 (0Bh) and COUNTER_BDR_REG2 (0Ch)). This allows triggering the reading of FIFO with the desired latency of one single sensor. The sensor is selectable using the TRIG_COUNTER_BDR_[1:0] bits in COUNTER_BDR_REG1 (0Bh). As for the other FIFO status events, the flag COUNTER_BDR_IA can be routed on the INT1 or INT2 pins by asserting the corresponding bits (INT1_CNT_BDR of INT1_CTRL (0Dh) and INT2_CNT_BDR of INT2_CTRL (0Eh)).

In order to maximize the amount of accelerometer and gyroscope data in FIFO, the user can enable the compression algorithm by setting to 1 both the FIFO_COMPR_EN bit in EMB_FUNC_EN_B (05h) (embedded functions registers bank) and the FIFO_COMPR_RT_EN bit in FIFO_CTRL2 (08h). When compression is enabled, it is also possible to force writing noncompressed data at a selectable rate using the UNCOMPR_RATE_[1:0] field in FIFO_CTRL2 (08h).

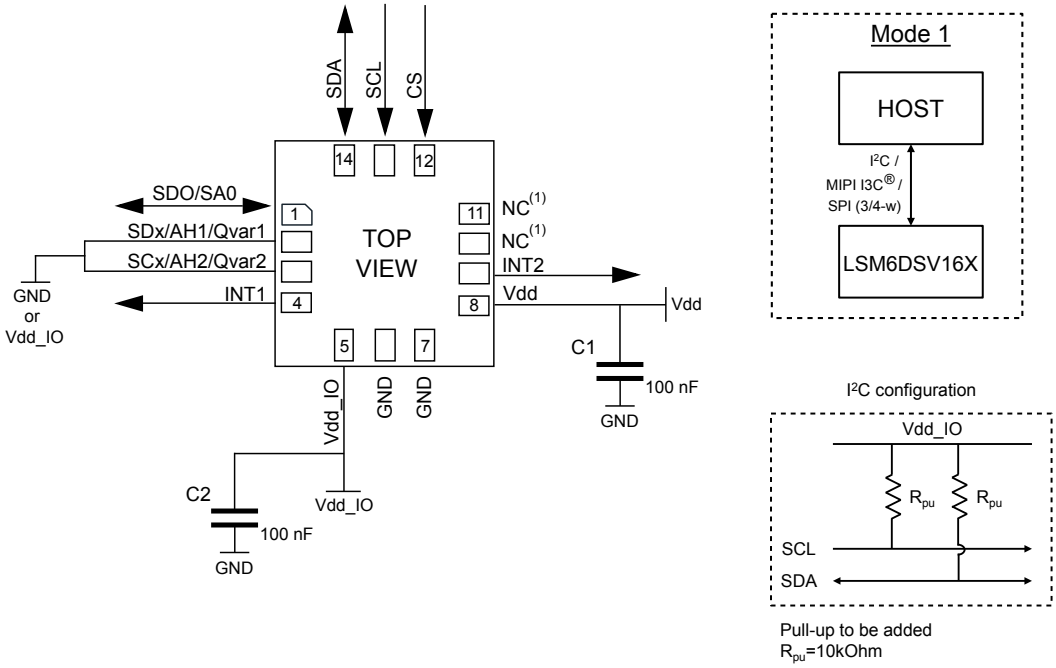
Meta information about accelerometer and gyroscope sensor configuration changes can be managed by enabling the ODR_CHG_EN bit in FIFO_CTRL2 (08h).

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7 Application hints

7.1 LSM6DSV16X electrical connections in mode 1

Figure 28. **LSM6DSV16X electrical connections in mode 1**



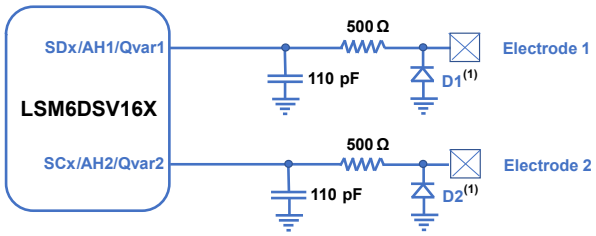
1. *Leave pin electrically unconnected and soldered to PCB.*

The device core is supplied through the Vdd line. Power supply decoupling capacitors (C1, C2 = 100 nF ceramic) should be placed as near as possible to the supply pin of the device (common design practice).

The functionality of the device and the measured acceleration/angular rate data is selectable and accessible through the SPI/I²C/MIPI I3C® interface.

The functions, the threshold, and the timing of the two interrupt pins for each sensor can be completely programmed by the user through the SPI/I²C/MIPI I3C® interface.

Figure 29. **Qvar external connections to pin 2, 3 (Qvar input)**



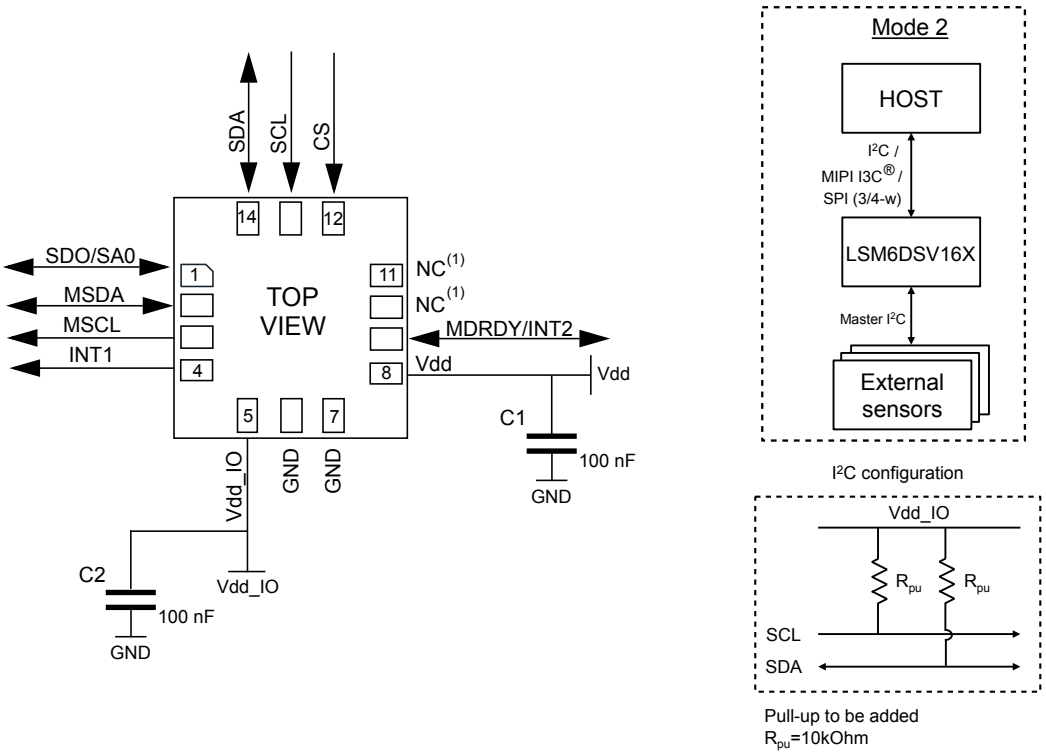
(1) ST ESDALCL5-1BM2 is referenced as an ST catalog product but similar features of other ESD diodes also can be used.

Note: Figure 29 provides an example of a test circuit. For a specific application, refer to the related application note.

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7.2 LSM6DSV16X electrical connections in mode 2

Figure 30. LSM6DSV16X electrical connections in mode 2



1. *Leave pin electrically unconnected and soldered to PCB.*

The device core is supplied through the Vdd line. Power supply decoupling capacitors (C1, C2 = 100 nF ceramic) should be placed as near as possible to the supply pin of the device (common design practice).

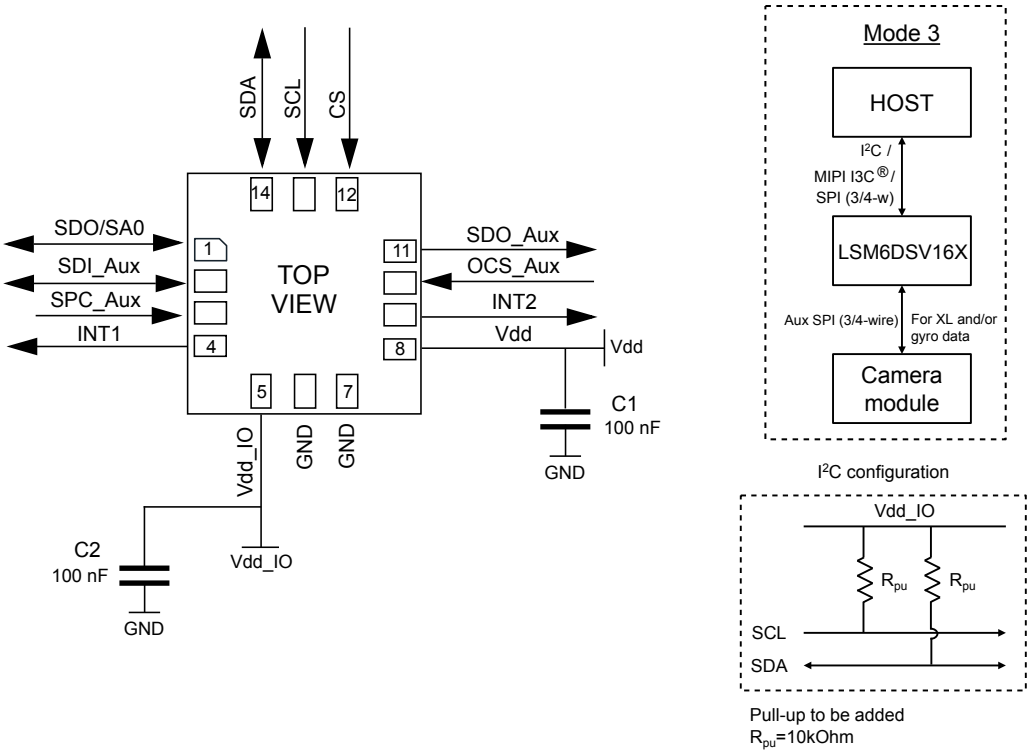
The functionality of the device and the measured acceleration/angular rate data is selectable and accessible through the SPI/I²C/MIPI I3C® primary interface.

The functions, the threshold, and the timing of the two interrupt pins for each sensor can be completely programmed by the user through the SPI/I²C/MIPI I3C® primary interface.

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7.3 LSM6DSV16X electrical connections in mode 3

Figure 31. LSM6DSV16X electrical connections in mode 3 (auxiliary 3/4-wire SPI)



Note: When mode 3 is used, the pull-up on pins 10 and 11 can be enabled or disabled (refer to Table 23. Internal pin status). To avoid leakage current, it is not recommended to leave the SPI lines floating (or when the OIS system is off).

The device core is supplied through the Vdd line. Power supply decoupling capacitors (C1, C2 = 100 nF ceramic) should be placed as near as possible to the supply pin of the device (common design practice).

The functionality of the device is selectable and accessible through the SPI/I²C/MIPI I3C® primary interface.

Measured acceleration/angular rate data is selectable and accessible through the SPI/I²C/MIPI I3C® primary interface and auxiliary SPI.

The functions, the threshold, and the timing of the two interrupt pins for each sensor can be completely programmed by the user through the SPI/I²C/MIPI I3C® interface.

Note: When mode 3 is used, refer to the product application note for the power mode configuration and settings.

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Table 23. Internal pin status

pin#	Name	Mode 1 function	Mode 2 function	Mode 3 function	Pin status mode 1	Pin status mode 2	Pin status mode 3 (1)
1	SDO	SPI 4-wire interface serial data output (SDO)	SPI 4-wire interface serial data output (SDO)	SPI 4-wire interface serial data output (SDO)	Default: input without pull-up Pull-up is enabled if bit SDO_PU_EN = 1 in register PIN_CTRL (02h).	Default: input without pull-up Pull-up is enabled if bit SDO_PU_EN = 1 in register PIN_CTRL (02h).	Default: input without pull-up Pull-up is enabled if bit SDO_PU_EN = 1 in register PIN_CTRL (02h).
	SA0	I²C least significant bit of the device address (SA0) MIPI I3C® least significant bit of the static address (SA0)	I²C least significant bit of the device address (SA0) MIPI I3C® least significant bit of the static address (SA0)	I²C least significant bit of the device address (SA0) MIPI I3C® least significant bit of the static address (SA0)			
2	SDx/AH1/ Qvar1	Connect to Vdd_IO or GND if the analog hub and/or Qvar are disabled. Connect to the analog input or Qvar electrode 1 if the Qvar function is enabled.(2)	I²C serial data master (MSDA)	Auxiliary SPI 3/4-wire interface serial data input (SDI_Aux) and SPI 3-wire serial data output (SDO_Aux)	Default: input without pull-up Pull-up is enabled if bit SHUB_PU_EN = 1 in register IF_CFG (03h).	Default: input without pull-up Pull-up is enabled if bit SHUB_PU_EN = 1 in register IF_CFG (03h).	Default: input without pull-up Pull-up is enabled if bit SHUB_PU_EN = 1 in register IF_CFG (03h).
3	SCx/AH2/ Qvar2	Connect to Vdd_IO or GND if the analog hub and/or Qvar are disabled. Connect to the analog input or Qvar electrode 2 if the Qvar function is enabled.(2)	I²C serial clock master (MSCL)	Auxiliary SPI 3/4-wire interface serial port clock (SPC_Aux)	Default: input without pull-up Pull-up is enabled if bit SHUB_PU_EN = 1 in register IF_CFG (03h).	Default: input without pull-up Pull-up is enabled if bit SHUB_PU_EN = 1 in register IF_CFG (03h).	Default: input without pull-up Pull-up is enabled if bit SHUB_PU_EN = 1 in register IF_CFG (03h)
4	INT1	Programmable interrupt 1	Programmable interrupt 1	Programmable interrupt 1	Default: output forced to ground	Default: output forced to ground	Default: output forced to ground
5	Vdd_IO	Power supply for I/O pins	Power supply for I/O pins	Power supply for I/O pins			
6	GND	0 V supply	0 V supply	0 V supply			
7	GND	0 V supply	0 V supply	0 V supply			
8	Vdd	Power supply	Power supply	Power supply			
9	INT2	Programmable interrupt 2 (INT2) / Data enabled (DEN)	Programmable interrupt 2 (INT2) / Data enabled (DEN) / I²C master external synchronization signal (MDRDY)	Programmable interrupt 2 (INT2) / Data enabled (DEN)	Default: output forced to ground	Default: output forced to ground	Default: output forced to ground
10	OCS_Aux	Connect to Vdd_IO or leave unconnected	Connect to Vdd_IO or leave unconnected	Auxiliary SPI 3/4-wire interface enabled	Default: input with pull-up Pull-up is disabled if bit OIS_PU_DIS = 1 in register PIN_CTRL (02h).	Default: input with pull-up Pull-up is disabled if bit OIS_PU_DIS = 1 in register PIN_CTRL (02h).	Default: input without pull-up (regardless of the value of bit OIS_PU_DIS in register PIN_CTRL (02h))
11	SDO_Aux	Connect to Vdd_IO or leave unconnected	Connect to Vdd_IO or leave unconnected	Auxiliary SPI 3-wire interface: leave unconnected / Auxiliary SPI 4-wire interface: serial data output (SDO_Aux)	Default: input with pull-up Pull-up is disabled if bit OIS_PU_DIS = 1 in register PIN_CTRL (02h).	Default: input with pull-up Pull-up is disabled if bit OIS_PU_DIS = 1 in register PIN_CTRL (02h).	Default: input without pull-up Pull-up is enabled if bit SIM_OIS = 1 (Aux_SPI 3-wire) in reg 70h and bit OIS_PU_DIS = 0 in register PIN_CTRL (02h).
12	CS	I²C/SPI mode selection (1: SPI idle mode / I²C communication enabled; 0: SPI communication mode / I²C disabled)	I²C/SPI mode selection (1: SPI idle mode / I²C communication enabled; 0: SPI communication mode / I²C disabled)	I²C/SPI mode selection (1: SPI idle mode / I²C communication enabled; 0: SPI communication mode / I²C disabled)	Default: input with pull-up Pull-up is disabled if bit I2C_I3C_disable = 1 in register IF_CFG (03h).	Default: input with pull-up Pull-up is disabled if bit I2C_I3C_disable = 1 in register IF_CFG (03h).	Default: input with pull-up Pull-up is disabled if bit I2C_I3C_disable = 1 in register IF_CFG (03h).

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pin#	Name	Mode 1 function	Mode 2 function	Mode 3 function	Pin status mode 1	Pin status mode 2	Pin status mode 3 (1)
13	SCL	I²C/MIPI I3C® serial clock (SCL) / SPI serial port clock (SPC)	I²C/MIPI I3C® serial clock (SCL) / SPI serial port clock (SPC)	I²C/MIPI I3C® serial clock (SCL) / SPI serial port clock (SPC)	Default: input without pull-up	Default: input without pull-up	Default: input without pull-up
14	SDA	I²C/MIPI I3C® serial data (SDA) / SPI serial data input (SDI) / 3-wire interface serial data output (SDO)	I²C/MIPI I3C® serial data (SDA) / SPI serial data input (SDI) / 3-wire interface serial data output (SDO)	I²C/MIPI I3C® serial data (SDA) / SPI serial data input (SDI) / 3-wire interface serial data output (SDO)	Default: input without pull-up Pull-up is enabled if bit SDA_PU_EN = 1 in register IF_CFG (03h).	Default: input without pull-up Pull-up is enabled if bit SDA_PU_EN = 1 in register IF_CFG (03h).	Default: input without pull-up Pull-up is enabled if bit SDA_PU_EN = 1 in register IF_CFG (03h).

1. *Mode 3 is enabled when the OIS_XL_EN bit or the OIS_G_EN bit in the UI_CTRL1_OIS (70h) / SPI2_CTRL1_OIS (70h) registers is set to 1.*
2. *The analog hub and Qvar functions are enabled by setting the AH_QVAR_EN bit to 1 in CTRL7 (16h).*

Internal pull-up value is from 30 kΩ to 50 kΩ, depending on Vdd_IO.

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8 Register mapping

The table given below provides a list of the 8/16-bit registers embedded in the device and the corresponding addresses.

All these registers are accessible from the primary SPI/I²C/MIPI I3C® interface only.

Table 24. Registers address map

Name	Type	Register address		Default	Comment
		Hex	Binary		
FUNC_CFG_ACCESS	R/W	01	00000001	00000000	
PIN_CTRL	R/W	02	00000010	00100011	
IF_CFG	R/W	03	00000011	00000000	
RESERVED	-	04-05			
ODR_TRIG_CFG	R/W	06	00000110	00000000	
FIFO_CTRL1	R/W	07	00000111	00000000	
FIFO_CTRL2	R/W	08	00001000	00000000	
FIFO_CTRL3	R/W	09	00001001	00000000	
FIFO_CTRL4	R/W	0A	00001010	00000000	
COUNTER_BDR_REG1	R/W	0B	00001011	00000000	
COUNTER_BDR_REG2	R/W	0C	00001100	00000000	
INT1_CTRL	R/W	0D	00001101	00000000	
INT2_CTRL	R/W	0E	00001110	00000000	
WHO_AM_I	R	0F	00001111	01110000	R (SPI2)
CTRL1	R/W	10	00010000	00000000	R (SPI2)
CTRL2	R/W	11	00010001	00000000	R (SPI2)
CTRL3	R/W	12	00010010	01000100	R (SPI2)
CTRL4	R/W	13	00010011	00000000	R (SPI2)
CTRL5	R/W	14	00010100	00000000	R (SPI2)
CTRL6	R/W	15	00010101	00000000	R (SPI2)
CTRL7	R/W	16	00010110	00000000	R (SPI2)
CTRL8	R/W	17	0001 0111	00000000	R (SPI2)
CTRL9	R/W	18	00011000	00000000	R (SPI2)
CTRL10	R/W	19	00011001	00000000	R (SPI2)
CTRL_STATUS	R	1A	00011010	output	
FIFO_STATUS1	R	1B	00011011	output	
FIFO_STATUS2	R	1C	00011100	output	
ALL_INT_SRC	R	1D	00011101	output	
STATUS_REG	R	1E	00011110	output	
RESERVED	-	1F			
OUT_TEMP_L	R	20	00100000	output	
OUT_TEMP_H	R	21	00100001	output	
OUTX_L_G	R	22	00100010	output	
OUTX_H_G	R	23	00100011	output	

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Name	Type	Register address		Default	Comment
		Hex	Binary		
OUTY_L_G	R	24	00100100	output	
OUTY_H_G	R	25	00100101	output	
OUTZ_L_G	R	26	00100110	output	
OUTZ_H_G	R	27	00100111	output	
OUTX_L_A	R	28	00101000	output	
OUTX_H_A	R	29	00101001	output	
OUTY_L_A	R	2A	00101010	output	
OUTY_H_A	R	2B	00101011	output	
OUTZ_L_A	R	2C	00101100	output	
OUTZ_H_A	R	2D	00101101	output	
UI_OUTX_L_G_OIS_EIS	R	2E	00101110	output	
UI_OUTX_H_G_OIS_EIS	R	2F	00101111	output	
UI_OUTY_L_G_OIS_EIS	R	30	00110000	output	
UI_OUTY_H_G_OIS_EIS	R	31	00110001	output	
UI_OUTZ_L_G_OIS_EIS	R	32	00110010	output	
UI_OUTZ_H_G_OIS_EIS	R	33	00110011	output	
UI_OUTX_L_A_OIS_DualC	R	34	00110100	output	
UI_OUTX_H_A_OIS_DualC	R	35	00110101	output	
UI_OUTY_L_A_OIS_DualC	R	36	00110110	output	
UI_OUTY_H_A_OIS_DualC	R	37	00110111	output	
UI_OUTZ_L_A_OIS_DualC	R	38	00111000	output	
UI_OUTZ_H_A_OIS_DualC	R	39	00111001	output	
AH_QVAR_OUT_L	R	3A	00111010	output	
AH_QVAR_OUT_H	R	3B	00111011	output	
RESERVED	-	3C-3F			
TIMESTAMP0	R	40	01000000	output	R (SPI2)
TIMESTAMP1	R	41	01000001	output	R (SPI2)
TIMESTAMP2	R	42	01000010	output	R (SPI2)
TIMESTAMP3	R	43	01000011	output	R (SPI2)
UI_STATUS_REG_OIS	R	44	01000100	output	
WAKE_UP_SRC	R	45	01000101	output	
TAP_SRC	R	46	01000110	output	
D6D_SRC	R	47	01000111	output	
STATUS_MASTER_ MAINPAGE	R	48	01001000	output	
EMB_FUNC_STATUS_ MAINPAGE	R	49	01001001	output	
FSM_STATUS_MAINPAGE	R	4A	01001010	output	
MLC_STATUS_MAINPAGE	R	4B	01001011	output	
RESERVED	-	4C-4E			
INTERNAL_FREQ_FINE	R	4F	01001111	output	

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Name	Type	Register address		Default	Comment
		Hex	Binary		
FUNCTIONS_ENABLE	RW	50	01010000	00000000	
DEN	R/W	51	01010001	00001110	
INACTIVITY_DUR	R/W	54	01010100	00000100	
INACTIVITY_THS	R/W	55	01010101	00000000	
TAP_CFG0	R/W	56	01010110	00000000	
TAP_CFG1	R/W	57	01010111	00000000	
TAP_CFG2	R/W	58	01011000	00000000	
TAP_THS_6D	R/W	59	01011001	00000000	
TAP_DUR	R/W	5A	01011010	00000000	
WAKE_UP_THS	R/W	5B	01011011	00000000	
WAKE_UP_DUR	R/W	5C	01011100	00000000	
FREE_FALL	R/W	5D	01011101	00000000	
MD1_CFG	R/W	5E	01011110	00000000	
MD2_CFG	R/W	5F	01011111	00000000	
RESERVED	-	60-61			
HAODR_CFG	R/W	62	01100010	00000000	
EMB_FUNC_CFG	R/W	63	01100011	00000000	
UI_HANDSHAKE_CTRL	R/W	64	01100100	00000000	
UI_SPI2_SHARED_0	R/W	65	01100101	00000000	
UI_SPI2_SHARED_1	R/W	66	01100110	00000000	
UI_SPI2_SHARED_2	R/W	67	01100111	00000000	
UI_SPI2_SHARED_3	R/W	68	01101000	00000000	
UI_SPI2_SHARED_4	R/W	69	01101001	00000000	
UI_SPI2_SHARED_5	R/W	6A	01101010	00000000	
CTRL_EIS	R/W	6B	01101011	00000000	
RESERVED	-	6C - 6E			
UI_INT_OIS	R (SPI2 full-control mode) R/W (primary IF full-control mode)	6F	01101111	00000000	
UI_CTRL1_OIS	R (SPI2 full-control mode) R/W (primary IF full-control mode)	70	01110000	00000000	
UI_CTRL2_OIS	R (SPI2 full-control mode) R/W (primary IF full-control mode)	71	01110001	00000000	
UI_CTRL3_OIS	R (SPI2 full-control mode) R/W (primary IF full-control mode)	72	01110010	00000000	
X_OFS_USR	R/W	73	01110011	00000000	
Y_OFS_USR	R/W	74	01110100	00000000	
Z_OFS_USR	R/W	75	01110101	00000000	
RESERVED	-	76-77			
FIFO_DATA_OUT_TAG	R	78	01111000	output	
FIFO_DATA_OUT_X_L	R	79	01111001	output	

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Name	Type	Register address		Default	Comment
		Hex	Binary		
FIFO_DATA_OUT_X_H	R	7A	01111010	output	
FIFO_DATA_OUT_Y_L	R	7B	01111011	output	
FIFO_DATA_OUT_Y_H	R	7C	01111100	output	
FIFO_DATA_OUT_Z_L	R	7D	01111101	output	
FIFO_DATA_OUT_Z_H	R	7E	01111110	output	

Reserved registers must not be changed. Writing to those registers may cause permanent damage to the device.

The content of the registers that are loaded at boot should not be changed. They contain the factory calibration values. Their content is automatically restored when the device is powered up.

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9 Register description

The device contains a set of registers which are used to control its behavior and to retrieve linear acceleration, angular rate, temperature, analog hub and Qvar data. The register addresses, made up of 7 bits, are used to identify them and to write the data through the serial interface.

9.1 FUNC_CFG_ACCESS (01h)

Enable embedded functions register (R/W)

Table 25. FUNC_CFG_ACCESS register

EMB_FUNC_ REG_ACCESS	SHUB_REG _ACCESS	0(1)	0(1)	FSM_WR_ CTRL_EN	SW_POR	SPI2_RESET	OIS_CTRL _FROM_UI

1. *This bit must be set to 0 for the correct operation of the device.*

Table 26. FUNC_CFG_ACCESS register description

EMB_FUNC_REG_ACCESS	Enables access to the embedded functions configuration registers. (1) Default value: 0
SHUB_REG_ACCESS	Enables access to the sensor hub (I²C master) configuration registers. (2) Default value: 0
FSM_WR_CTRL_EN	Enables the control of the CTRL registers to FSM (FSM can change some configurations of the device autonomously). Default value: 0 (0: disabled; 1: enabled)
SW_POR	Global reset of the device. Default value: 0
SPI2_RESET	Resets the control registers of SPI2 from the primary interface. This bit must be set to 1 and then back to 0 (this bit is not automatically cleared). Default value: 0
OIS_CTRL_FROM_UI	Enables the full control of OIS configurations from the primary interface. Default value: 0 (0: OIS chain full control from primary interface disabled; 1: OIS chain full control from primary interface enabled)

1. *Details concerning the embedded functions configuration registers are available in Section 12 Embedded functions register mapping and Section 13 Embedded functions register description.*
2. *Details concerning the sensor hub registers are available in Section 16 Sensor hub register mapping and Section 17 Sensor hub register description.*

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9.2 PIN_CTRL (02h)

SDO, OCS_Aux, SDO_Aux pins pull-up register (R/W). This register is not reset during the software reset procedure (see bit 0 of the CTRL3 (12h) register).

Table 27. PIN_CTRL register

OIS_ PU_DIS	SDO_ PU_EN	IBHR_ POR_EN	0(1)	0(1)	0(1)	1(2)	1(2)

1. *This bit must be set to 0 for the correct operation of the device.*
2. *This bit must be set to 1 for the correct operation of the device.*

Table 28. PIN_CTRL register description

OIS_PU_DIS	Disables pull-up on both OCS_Aux and SDO_Aux pins (for mode 1 and mode 2). For further details about the configuration of the pull-up resistors in mode 3, refer to Table 23. Default value: 0 (0: OCS_Aux and SDO_Aux pins with pull-up; 1: OCS_Aux and SDO_Aux pins pull-up disconnected)
SDO_PU_EN	Enables pull-up on SDO pin. For details, refer to Table 23. Default value: 0 (0: SDO pin pull-up disconnected; 1: SDO pin with pull-up)
IBHR_POR_EN	Selects the action the device performs after "reset whole chip" I3C pattern. Default value: 1 (0: configuration reset (SW reset + dynamic address reset); (1: global reset (POR reset))

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9.3 IF_CFG (03h)

Interface configuration register (R/W). This register is not reset during the software reset procedure (see bit 0 of the CTRL3 (12h) register).

Table 29. IF_CFG register

SDA_PU_EN	SHUB_ PU_EN	ASF_CTRL	H_LACTIVE	PP_OD	SIM	0(1)	I2C_I3C_ disable

1. *This bit must be set to 0 for the correct operation of the device.*

Table 30. IF_CFG register description

SDA_PU_EN	Enables pull-up on SDA pin. Default value: 0 (0: SDA pin pull-up disconnected; 1: SDA pin with pull-up)
SHUB_PU_EN	Enables master I²C pull-up. Default value: 0 (0: internal pull-up on auxiliary I²C line disabled; 1: internal pull-up on auxiliary I²C line enabled)
ASF_CTRL	Enables anti-spike filters. Default value: 0 (0: anti-spike filters are managed by the protocol and turned off after the broadcast address; 1: anti-spike filters on SCL and SDA lines are always enabled)
H_LACTIVE	Interrupt activation level. Default value: 0 (0: interrupt output pins active high; 1: interrupt output pins active low)
PP_OD	Push-pull/open-drain selection on INT1 and INT2 pins. Default value: 0 (0: push-pull mode; 1: open-drain mode)
SIM	SPI serial interface mode selection. Default value: 0 (0: 4-wire interface; 1: 3-wire interface)
I2C_I3C_disable	Disables I²C and MIPI I3C® interfaces. Default value: 0 (0: SPI, I²C and MIPI I3C® interfaces enabled; 1: I²C and MIPI I3C® interfaces disabled)

9.4 ODR_TRIG_CFG (06h)

ODR-triggered mode configuration register (R/W)

Table 31. ODR_TRIG_CFG register

ODR_TRIG_ NODR_7	ODR_TRIG_ NODR_6	ODR_TRIG_ NODR_5	ODR_TRIG_ NODR_4	ODR_TRIG_ NODR_3	ODR_TRIG_ NODR_2	ODR_TRIG_ NODR_1	ODR_TRIG_ NODR_0

Table 32. ODR_TRIG_CFG register description

ODR_TRIG_NODR_[7:0]	When ODR-triggered mode is set, these bits are used to define the number of data generated in the reference period. Allowed values for ODR_TRIG_NODR_[7:0] are 0 (default) and values in the range from 4 to 255.

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9.5 FIFO_CTRL1 (07h)

FIFO control register 1 (R/W)

Table 33. FIFO_CTRL1 register

WTM_7	WTM_6	WTM_5	WTM_4	WTM_3	WTM_2	WTM_1	WTM_0

Table 34. FIFO_CTRL1 register description

WTM_[7:0]	FIFO watermark threshold: 1 LSB = TAG (1 byte) + 1 sensor (6 bytes) written in FIFO. Watermark flag rises when the number of bytes written in the FIFO is greater than or equal to the threshold level.

9.6 FIFO_CTRL2 (08h)

FIFO control register 2 (R/W)

Table 35. FIFO_CTRL2 register

STOP_ON_WTM	FIFO_COMPR_RT_EN	0(1)	ODR_CHG_EN	0(1)	UNCOMPR_RATE_1	UNCOMPR_RATE_0	XL_DualC_BATCH_FROM_FSM

1. *This bit must be set to 0 for the correct operation of the device.*

Table 36. FIFO_CTRL2 register description

STOP_ON_WTM	Sensing chain FIFO stop values memorization at threshold level. Default value: 0 (0: FIFO depth is not limited; 1: FIFO depth is limited to threshold level, defined in FIFO_CTRL1 (07h))
FIFO_COMPR_RT_EN(1)	Enables/disables compression algorithm runtime. Default value: 0 (0: FIFO compression algorithm disabled; 1: FIFO compression algorithm enabled)
ODR_CHG_EN	Enables ODR CHANGE virtual sensor to be batched in FIFO. Default value: 0 (0: ODR CHANGE virtual sensor not batched in FIFO; 1: ODR CHANGE virtual sensor batched in FIFO) *Note: Refer to the product application note for the details regarding operating/power mode configurations, settings, turn-on/off time and on-the-fly changes.*
UNCOMPR_RATE_[1:0]	This field configures the compression algorithm to write uncompressed data at each rate. (0: uncompressed data writing is not forced (default); 1: uncompressed data every 8 batch data rate; 2: uncompressed data every 16 batch data rate; 3: uncompressed data every 32 batch data rate)
XL_DualC_BATCH_FROM_FSM	When dual-channel mode is enabled, this bit enables FSM-triggered batching in FIFO of accelerometer channel 2. Default value: 0 (0: disabled; 1: enabled)

1. *This bit is activated if the FIFO_COMPR_EN bit of EMB_FUNC_EN_B (05h) is set to 1.*

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9.7 FIFO_CTRL3 (09h)

FIFO control register 3 (R/W)

Table 37. FIFO_CTRL3 register

BDR_GY_3	BDR_GY_2	BDR_GY_1	BDR_GY_0	BDR_XL_3	BDR_XL_2	BDR_XL_1	BDR_XL_0

Table 38. FIFO_CTRL3 register description

BDR_GY_[3:0]	Selects batch data rate (write frequency in FIFO) for gyroscope data. (0000: gyroscope not batched in FIFO (default); 0001: 1.875 Hz; 0010: 7.5 Hz; 0011: 15 Hz; 0100: 30 Hz; 0101: 60 Hz; 0110: 120 Hz; 0111: 240 Hz; 1000: 480 Hz; 1001: 960 Hz; 1010: 1.92 kHz; 1011: 3.84 kHz; 1100: 7.68 kHz 1101-1111: reserved)
BDR_XL_[3:0]	Selects batch data rate (write frequency in FIFO) for accelerometer data. (0000: accelerometer not batched in FIFO (default); 0001: 1.875 Hz; 0010: 7.5 Hz; 0011: 15 Hz; 0100: 30 Hz; 0101: 60 Hz; 0110: 120 Hz; 0111: 240 Hz; 1000: 480 Hz; 1001: 960 Hz; 1010: 1.92 kHz; 1011: 3.84 kHz; 1100: 7.68 kHz 1101-1111: reserved)

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9.8 FIFO_CTRL4 (0Ah)

FIFO control register 4 (R/W)

Table 39. FIFO_CTRL4 register

DEC_TS_ BATCH_1	DEC_TS_ BATCH_0	ODR_T_ BATCH_1	ODR_T_ BATCH_0	G_EIS_ FIFO_EN	FIFO_ MODE_2	FIFO_ MODE_1	FIFO_ MODE_0

Table 40. FIFO_CTRL4 register description

DEC_TS_BATCH_[1:0]	Selects decimation for timestamp batching in FIFO. Write rate is the maximum rate between the accelerometer and gyroscope BDR divided by decimation decoder. (00: timestamp not batched in FIFO (default); 01: decimation 1: max(BDR_XL[Hz],BDR_GY[Hz]) [Hz]; 10: decimation 8: max(BDR_XL[Hz],BDR_GY[Hz])/8 [Hz]; 11: decimation 32: max(BDR_XL[Hz],BDR_GY[Hz])/32 [Hz])
ODR_T_BATCH_[1:0]	Selects batch data rate (write frequency in FIFO) for temperature data (00: temperature not batched in FIFO (default); 01: 1.875 Hz; 10: 15 Hz; 11: 60 Hz)
G_EIS_FIFO_EN	Enables FIFO batching of enhanced EIS gyroscope output values. Default value: 0 (0: disabled; 1: enabled)
FIFO_MODE_[2:0]	FIFO mode selection (000: bypass mode: FIFO disabled (default); 001: FIFO mode: stops collecting data when FIFO is full; 010: continuousWTM-to-full mode: continuous mode with FIFO watermark size until trigger is deasserted, then data are stored in FIFO until the buffer is full; 011: continuous-to-FIFO mode: continuous mode until trigger is deasserted, then FIFO mode; 100: bypass-to-continuous mode: bypass mode until trigger is deasserted, then continuous mode; 101: reserved; 110: continuous mode: if the FIFO is full, the new sample overwrites the older one; 111: bypass-to-FIFO mode: bypass mode until trigger is deasserted, then FIFO mode.)

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9.9 COUNTER_BDR_REG1 (0Bh)

Counter batch data rate register 1 (R/W)

Table 41. COUNTER_BDR_REG1 register

0(1)	TRIG_COUNTER_BDR_1	TRIG_COUNTER_BDR_0	0(1)	0(1)	0(1)	CNT_BDR_TH_9	CNT_BDR_TH_8

1. *This bit must be set to 0 for the correct operation of the device.*

Table 42. COUNTER_BDR_REG1 register description

TRIG_COUNTER_BDR_[1:0]	Selects the trigger for the internal counter of batch events between the accelerometer, gyroscope and EIS gyroscope. (00: accelerometer batch event; 01: gyroscope batch event; 10 – 11: gyroscope EIS batch event)
CNT_BDR_TH_[9:8]	In conjunction with CNT_BDR_TH_[7:0] in COUNTER_BDR_REG2 (0Ch), sets the threshold for the internal counter of batch events. When this counter reaches the threshold, the counter is reset and the COUNTER_BDR_IA flag in FIFO_STATUS2 (1Ch) is set to 1.

9.10 COUNTER_BDR_REG2 (0Ch)

Counter batch data rate register 2 (R/W)

Table 43. COUNTER_BDR_REG2 register

CNT_BDR_TH_7	CNT_BDR_TH_6	CNT_BDR_TH_5	CNT_BDR_TH_4	CNT_BDR_TH_3	CNT_BDR_TH_2	CNT_BDR_TH_1	CNT_BDR_TH_0

Table 44. COUNTER_BDR_REG2 register description

CNT_BDR_TH_[7:0]	In conjunction with CNT_BDR_TH_[9:8] in COUNTER_BDR_REG1 (0Bh), sets the threshold for the internal counter of batch events. When this counter reaches the threshold, the counter is reset and the COUNTER_BDR_IA flag in FIFO_STATUS2 (1Ch) is set to 1.

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9.11 INT1_CTRL (0Dh)

INT1 pin control register (R/W)

Each bit in this register enables a signal to be carried over INT1 when the MIPI I3C® dynamic address is not assigned (I²C or SPI is used). Some bits can be also used to trigger an IBI (in-band interrupt) when the MIPI I3C® interface is used. The output of the pin is the OR combination of the signals selected here and in MD1_CFG (5Eh).

Table 45. INT1_CTRL register

0(1)	INT1_ CNT_BDR	INT1_ FIFO_FULL	INT1_ FIFO_OVR	INT1_ FIFO_TH	0(1)	INT1_ DRDY_G	INT1_ DRDY_XL

1. *This bit must be set to 0 for the correct operation of the device.*

Table 46. INT1_CTRL register description

INT1_CNT_BDR	Enables COUNTER_BDR_IA interrupt on INT1 pin. Default value: 0
INT1_FIFO_FULL	Enables FIFO full flag interrupt on INT1 pin. It can be also used to trigger an IBI when the MIPI I3C® interface is used. Default value: 0
INT1_FIFO_OVR	Enables FIFO overrun interrupt on INT1 pin. It can be also used to trigger an IBI when the MIPI I3C® interface is used. Default value: 0
INT1_FIFO_TH	Enables FIFO threshold interrupt on INT1 pin. It can be also used to trigger an IBI when the MIPI I3C® interface is used. Default value: 0
INT1_DRDY_G	Enables gyroscope data-ready interrupt on INT1 pin. It can be also used to trigger an IBI when the MIPI I3C® interface is used. Default value: 0
INT1_DRDY_XL	Enables accelerometer data-ready interrupt on INT1 pin. It can be also used to trigger an IBI when the MIPI I3C® interface is used. Default value: 0

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9.12 INT2_CTRL (0Eh)

INT2 pin control register (R/W)

Each bit in this register enables a signal to be carried over INT2 when the MIPI I3C® dynamic address is not assigned (I²C or SPI is used). Some bits can be also used to trigger an IBI when the MIPI I3C® interface is used. The output of the pin is the OR combination of the signals selected here and in MD2_CFG (5Fh).

Table 47. INT2_CTRL register

INT2_EMB_FUNC_ENDOP	INT2_CNT_BDR	INT2_FIFO_FULL	INT2_FIFO_OVR	INT2_FIFO_TH	INT2_DRDY_G_EIS	INT2_DRDY_G	INT2_DRDY_XL

Table 48. INT2_CTRL register description

INT2_EMB_FUNC_ENDOP	Enables routing the embedded functions end of operations signal to the INT2 pin. Default value: 0
INT2_CNT_BDR	Enables COUNTER_BDR_IA interrupt on INT2. Default value: 0
INT2_FIFO_FULL	Enables FIFO full flag interrupt on INT2 pin.Default value: 0
INT2_FIFO_OVR	Enables FIFO overrun interrupt on INT2 pin. Default value: 0
INT2_FIFO_TH	Enables FIFO threshold interrupt on INT2 pin. Default value: 0
INT2_DRDY_G_EIS	Enables gyroscope EIS data-ready interrupt on INT2 pin. Default value: 0
INT2_DRDY_G	Gyroscope data-ready interrupt on INT2 pin. Default value: 0
INT2_DRDY_XL	Accelerometer data-ready interrupt on INT2 pin. Default value: 0

9.13 WHO_AM_I (0Fh)

WHO_AM_I register (R). This is a read-only register. Its value is fixed at 70h.

Table 49. WhoAmI register

0	1	1	1	0	0	0	0

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9.14 CTRL1 (10h)

Accelerometer control register 1 (R/W)

Table 50. CTRL1 register

0(1)	OP_MODE_XL_2	OP_MODE_XL_1	OP_MODE_XL_0	ODR_XL_3	ODR_XL_2	ODR_XL_1	ODR_XL_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 51. CTRL1 register description

OP_MODE_XL_[2:0]	Accelerometer operating mode selection. (000: high-performance mode (default); 001: high-accuracy ODR mode; 010: reserved; 011: ODR-triggered mode; 100: low-power mode 1 (2 mean); 101: low-power mode 2 (4 mean); 110: low-power mode 3 (8 mean); 111: normal mode)
ODR_XL_[3:0]	Accelerometer ODR selection (see Table 52)

Table 52. Accelerometer ODR selection

ODR_XL_3	ODR_XL_2	ODR_XL_1	ODR_XL_0	ODR selection [Hz]
0	0	0	0	Power-down (default)
0	0	0	1	1.875 Hz (low-power mode)
0	0	1	0	7.5 Hz (high-performance, normal mode)
0	0	1	1	15 Hz (low-power, high-performance, normal mode)
0	1	0	0	30 Hz (low-power, high-performance, normal mode)
0	1	0	1	60 Hz (low-power, high-performance, normal mode)
0	1	1	0	120 Hz (low-power, high-performance, normal mode)
0	1	1	1	240 Hz (low-power, high-performance, normal mode)
1	0	0	0	480 Hz (high-performance, normal mode)
1	0	0	1	960 Hz (high-performance, normal mode)
1	0	1	0	1.92 kHz (high-performance, normal mode)
1	0	1	1	3.84 kHz (high-performance mode)
1	1	0	0	7.68 kHz (high-performance mode)
Others				Reserved

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9.15 CTRL2 (11h)

Gyroscope control register 2 (R/W)

Table 53. CTRL2 register

0(1)	OP_MODE_G_2	OP_MODE_G_1	OP_MODE_G_0	ODR_G_3	ODR_G_2	ODR_G_1	ODR_G_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 54. CTRL2 register description

OP_MODE_G_[2:0]	Gyroscope operating mode selection. (000: high-performance mode (default); 001: high-accuracy ODR mode; 010: reserved; 011: ODR-triggered mode; 100: sleep mode; 101: low-power mode; 110-111: reserved)
ODR_G_[3:0]	Gyroscope output data rate selection. (See Table 55)

Table 55. Gyroscope ODR selection

ODR_G_3	ODR_G_2	ODR_G_1	ODR_G_0	ODR [Hz]
0	0	0	0	Power-down (default)
0	0	1	0	7.5 Hz (low-power, high-performance mode)
0	0	1	1	15 Hz (low-power, high-performance mode)
0	1	0	0	30 Hz (low-power, high-performance mode)
0	1	0	1	60 Hz (low-power, high-performance mode)
0	1	1	0	120 Hz (low-power, high-performance mode)
0	1	1	1	240 Hz (low-power, high-performance mode)
1	0	0	0	480 Hz (high-performance mode)
1	0	0	1	960 Hz (high-performance mode)
1	0	1	0	1.92 kHz (high-performance mode)
1	0	1	1	3.84 kHz (high-performance mode)
1	1	0	0	7.68 kHz (high-performance mode)
Others				Reserved

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9.16 CTRL3 (12h)

Control register 3 (R/W)

Table 56. CTRL3 register

BOOT	BDU	0(1)	0(1)	0(1)	IF_INC	0(1)	SW_RESET

1. *This bit must be set to 0 for the correct operation of the device.*

Table 57. CTRL3 register description

BOOT	Reboots memory content. This bit is automatically cleared. Default value: 0 (0: normal mode; 1: reboot memory content)
BDU	Block data update. Default value: 1 (0: continuous update; 1: output registers are not updated until LSB and MSB have been read)
IF_INC	Register address automatically incremented during a multiple byte access with a serial interface (I²C, MIPI I3C, or SPI). Default value: 1 (0: disabled; 1: enabled)
SW_RESET	Software reset, resets all control registers to their default value. This bit is automatically cleared. Default value: 0 (0: normal mode; 1: reset device)

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9.17 CTRL4 (13h)

Control register 4 (R/W)

Table 58. CTRL4 register

0(1)	0(1)	0(1)	INT2_on_INT1	DRDY_MASK	INT2_DRDY_TEMP	DRDY_PULSED	INT2_IN_LH

1. *This bit must be set to 0 for the correct operation of the device.*

Table 59. CTRL4 register description

INT2_on_INT1	Enables routing the embedded functions interrupt signals to the INT1 pin. Default value: 0 • The corresponding bits in the INT2 control registers need to be enabled. • These interrupts are in OR with those enabled on the INT1 pin. • They are not fed to the INT2 pin. • The movable interrupts are: – INT2_DRDY_G_EIS and INT2_EMB_FUNC_ENDOP, enabled through INT2_CTRL (0Eh) – INT2_TIMESTAMP enabled through MD2_CFG (5Fh) – INT2_DRDY_TEMP enabled through CTRL4 (13h) – INT2_DRDY_AH_QVAR enabled through Section 9.20
DRDY_MASK	Enables / masks data-ready signal. Default value: 0 (0: disabled; 1: masks DRDY signals (both accelerometer and gyroscope) until filter settling ends (accelerometer and gyroscope independently masked)) *Note: Refer to the product application note for the details regarding operating/power mode configurations, settings, turn-on/off time and on-the-fly changes.*
INT2_DRDY_TEMP	Enables temperature sensor data-ready interrupt on the INT2 pin. It can be also used to trigger an IBI when the MIPI I3C® interface is used and INT2_ON_INT1 = 1 in CTRL4_C (13h). Default value: 0 (0: disabled; 1: enabled)
DRDY_PULSED	Enables pulsed data-ready mode. Default value: 0 (0: data-ready latched mode (returns to 0 only after the higher part of the associated output register has been read); 1: data-ready pulsed mode (the data-ready pulses are 65 µs long))
INT2_IN_LH	Set to 1 in order to change the polarity of the INT2 pin input trigger for DEN or embedded functions. Default value: 0 (0: trigger for DEN and embedded functions pin is active low; 1: trigger for DEN and embedded functions pin is active high)

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9.18 CTRL5 (14h)

Control register 5 (R/W)

Table 60. CTRL5 register

0(1)	0(1)	0(1)	0(1)	0(1)	BUS_ACT_SEL_1	BUS_ACT_SEL_0	INT_EN_I3C

1. *This bit must be set to 0 for the correct operation of the device.*

Table 61. CTRL5 register description

BUS_ACT_SEL_[1:0]	Bus available time selection for IBI (in-band interrupt): 00: 2 µs; 01: 50 µs (default); 10: 1 ms; 11: 25 ms)
INT_EN_I3C	Enables INT pin when I3C is enabled. Default value: 0 (0: disabled; 1: enabled)

9.19 CTRL6 (15h)

Control register 6 (R/W)

Table 62. CTRL6 register

0(1)	LPF1_G_BW_2	LPF1_G_BW_1	LPF1_G_BW_0	FS_G_3	FS_G_2	FS_G_1	FS_G_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 63. CTRL6 register description

LPF1_G_BW_[2:0]	Gyroscope low-pass filter (LPF1) bandwidth selection Table 64 shows the selectable bandwidth values (available if OIS and/or EIS are disabled).
FS_G_[3:0]	Gyroscope UI chain full-scale selection: (0000: ±125 dps (default); 0001: ±250 dps; 0010: ±500 dps; 0011: ±1000 dps; 0100: ±2000 dps; 1100: ±4000 dps(1) Others: reserved)

1. *When FS = ±4000 dps is selected, the gyroscope OIS chain must be disabled (OIS_G_EN bit of UI_CTRL1_OIS (70h) / SPI2_CTRL1_OIS (70h) must be set to 0).*

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Table 64. **Gyroscope LPF1 + LPF2 bandwidth selection**

LPF1_G_BW_[2:0]	60 Hz	120 Hz	240 Hz	480 Hz	960 Hz	1.92 kHz	3.84 kHz	7.68 kHz
000	24.6	49.4	96	175	241	273	280	281
001	24.6	49.4	96	157	195	210	213	213
010	24.6	49.4	96	131	149	155	156	156
011	24.6	49.4	96	188	310	387	403	407
100	24.6	49.4	78.4	94	100	101	102	102
101	24.6	42.6	53	56.7	57.9	58.2	58.3	58
110	18.0	24.2	27.3	28.4	28.7	28.8	28.8	28.8
111	12.1	13.6	14.2	14.3	14.4	14.4	14.4	14.4

9.20 CTRL7 (16h)

Control register 7 (R/W)

Table 65. **CTRL7 register**

AH_QVAR_EN	INT2_DRDY_AH_QVAR	AH_QVAR_C_ZIN_1	AH_QVAR_C_ZIN_0	0(1)	0(1)	0(1)	LPF1_G_EN

1. *This bit must be set to 0 for the correct operation of the device.*

Table 66. **CTRL7 register description**

AH_QVAR_EN	Enables the analog hub and Qvar chain. When this bit is set to 1, the analog hub and Qvar buffers are connected to the SDx/AH1/Qvar1 and SCx/AH2/Qvar2 pins. Before setting this bit to 1, the accelerometer and gyroscope sensors have to be configured in power-down mode. Default value: 0 (0: disabled; 1: enabled)
INT2_DRDY_AH_QVAR	Analog hub and Qvar data-ready interrupt on the INT2 pin. Default value: 0 (0: disabled; 1: enabled)
AH_QVAR_C_ZIN_[1:0]	Configures the equivalent input impedance of the analog hub and Qvar buffers. (00: 2.4 GΩ (default); 01: 730 MΩ; 10: 300 MΩ; 11: 235 MΩ)
LPF1_G_EN	Enables the gyroscope digital LPF1 filter. If the OIS chain is disabled, the bandwidth can be selected through LPF1_G_BW_[2:0] in CTRL6 (15h)

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9.21 CTRL8 (17h)

Control register 8 (R/W)

Table 67. CTRL8 register

HP_LPF2_XL_BW_2	HP_LPF2_XL_BW_1	HP_LPF2_XL_BW_0	0(1)	XL_DualC_EN	0(1)	FS_XL_1	FS_XL_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 68. CTRL8 register description

HP_LPF2_XL_BW_[2:0]	Accelerometer LPF2 and HP filter configuration and cutoff setting. Refer to Table 69.
XL_DualC_EN	Enables dual-channel mode. When this bit is set to 1, data with the maximum full scale are sent to the output registers at addresses 34h to 39h. The UI processing chain is used. Default value: 0 (0: disabled; 1: enabled)
FS_XL_[1:0]	Accelerometer full-scale selection: (00: ±2 *g*; 01: ±4 *g*; 10: ±8 *g*; 11: ±16 *g*)

Table 69. Accelerometer bandwidth configurations

Filter type	HP_SLOPE_XL_EN	LPF2_XL_EN	HP_LPF2_XL_BW_[2:0]	Bandwidth
Low pass	0	0	-	ODR/2(1)
		1	000	ODR/4
			001	ODR/10
			010	ODR/20
			011	ODR/45
			100	ODR/100
			101	ODR/200
			110	ODR/400
			111	ODR/800
High pass	1	-	000	SLOPE (ODR/4)
			001	ODR/10
			010	ODR/20
			011	ODR/45
			100	ODR/100
			101	ODR/200
			110	ODR/400
			111	ODR/800

1. *This value is ODR/2 when the accelerometer is in high-performance mode, high-accuracy ODR mode and normal mode. It is equal to 2300 Hz when the accelerometer is in low-power mode 1 (2 mean), 912 Hz in low-power mode 2 (4 mean) and 431 Hz in low-power mode 3 (8 mean).*

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9.22 CTRL9 (18h)

Control register 9 (R/W)

Table 70. CTRL9 register

0(1)	HP_REF_MODE_XL	XL_FASTSETTL_MODE	HP_SLOPE_XL_EN	LPF2_XL_EN	0(1)	USR_OFF_W	USR_OFF_ON_OUT

1. *This bit must be set to 0 for the correct operation of the device.*

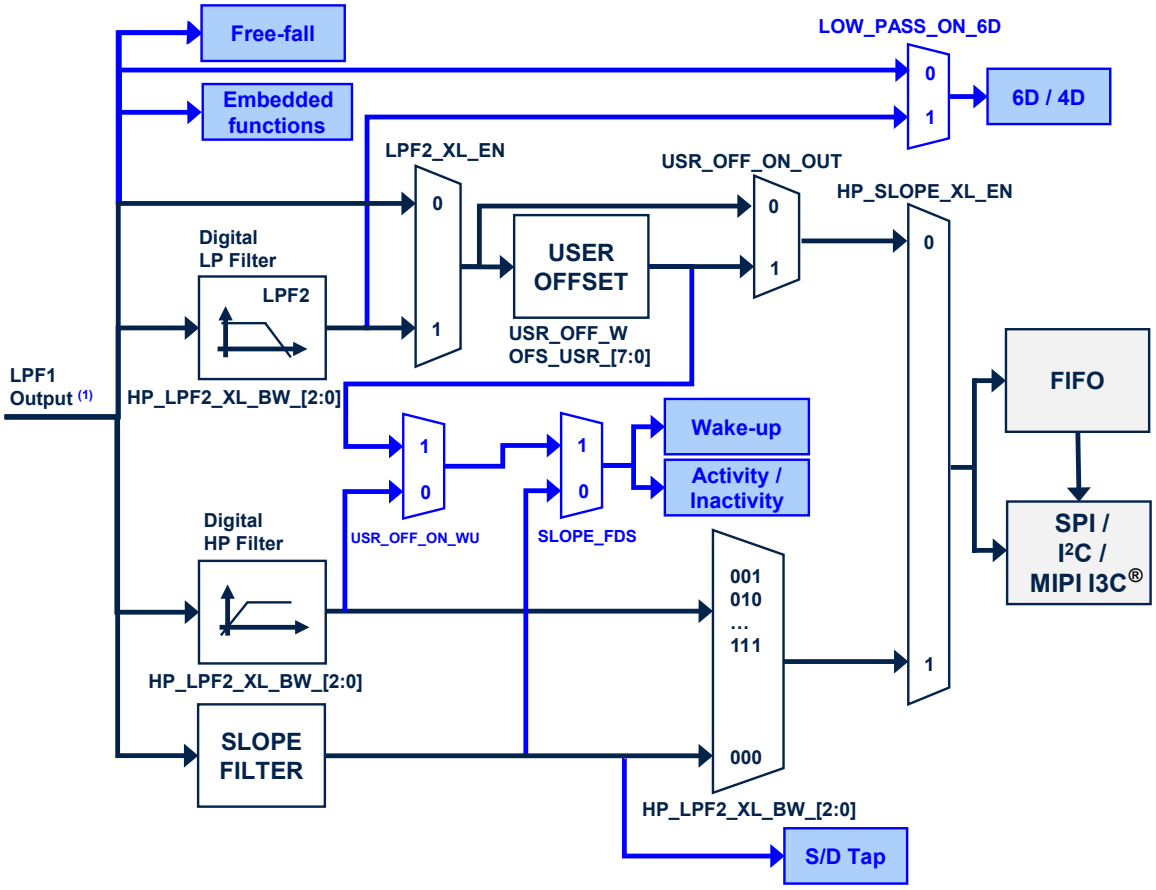
Table 71. CTRL9 register description

HP_REF_MODE_XL	Enables accelerometer high-pass filter reference mode (valid for high-pass path - HP_SLOPE_XL_EN bit must be 1). Default value: 0 (0: disabled, 1: enabled)(1)
XL_FASTSETTL_MODE	Enables accelerometer LPF2 and HPF fast-settling mode. The filter sets the first sample after writing this bit. Active only during device exit from power-down mode. Default value: 0 (0: disabled, 1: enabled)
HP_SLOPE_XL_EN	Accelerometer slope filter / high-pass filter selection. Refer to Figure 32. Default value: 0 (0: low-pass filter path selected; 1: high-pass filter path selected)
LPF2_XL_EN	Accelerometer high-resolution selection. Refer to Figure 32. Default value: 0 (0: output from first stage digital filtering selected; 1: output from LPF2 second filtering stage selected)
USR_OFF_W	Weight of XL user offset bits of registers X_OFS_USR (73h), Y_OFS_USR (74h), Z_OFS_USR (75h). Default value: 0 (0: 2^{-10} *g*/LSB; 1: 2^{-6} *g*/LSB)
USR_OFF_ON_OUT	Enables accelerometer user offset correction block; it is valid for the low-pass path. Refer to Figure 32. Default value: 0 (0: accelerometer user offset correction block bypassed; 1: accelerometer user offset correction block enabled)

1. *When enabled, the first output data has to be discarded.*

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Figure 32. **Accelerometer block diagram**



1. *The cutoff value of the LPF1 output is ODR/2 when the accelerometer is in high-performance mode, high-accuracy ODR mode or normal mode. This value is equal to 2300 Hz when the accelerometer is in low-power mode 1 (2 mean), 912 Hz in low-power mode 2 (4 mean) or 431 Hz in low-power mode 3 (8 mean).*

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9.23 CTRL10 (19h)

Control register 10 (R/W)

Table 72. CTRL10 register

0(1)	EMB_FUNC_DEBUG	0(1)	0(1)	ST_G_1	ST_G_0	ST_XL_1	ST_XL_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 73. CTRL10 register description

EMB_FUNC_DEBUG	Enables debug mode for the embedded functions. (0: disabled; 1: enabled)
ST_G_[1:0]	Gyroscope self-test selection (00: normal mode (default); 01: positive sign self-test; 10: negative sign self-test; 11: reserved)
ST_XL_[1:0]	Accelerometer self-test selection (00: normal mode (default); 01: positive sign self-test; 10: negative sign self-test; 11: reserved)

9.24 CTRL_STATUS (1Ah)

(R)

Table 74. CTRL_STATUS register

0	0	0	0	0	FSM_WR_CTRL_STATUS	-	0

Table 75. CTRL_STATUS register description

FSM_WR_CTRL_STATUS	This flag indicates the current controller of the device configuration registers. This flag must be used as an acknowledge flag when the value of the FSM_WR_CTRL_EN bit in the FUNC_CFG_ACCESS (01h) register is changed. Default value: 0 (0: all registers and configurations are writable from the standard interface; 1: some registers and configurations are under FSM control and are in read-only mode from the standard interface).

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9.25 FIFO_STATUS1 (1Bh)

FIFO status register 1 (R)

Table 76. FIFO_STATUS1 register

DIFF_ FIFO_7	DIFF_ FIFO_6	DIFF_ FIFO_5	DIFF_ FIFO_4	DIFF_ FIFO_3	DIFF_ FIFO_2	DIFF_ FIFO_1	DIFF_ FIFO_0

Table 77. FIFO_STATUS1 register description

DIFF_FIFO_[7:0]	Number of unread sensor data (TAG + 6 bytes) stored in FIFO In conjunction with DIFF_FIFO_8 in FIFO_STATUS2 (1Ch).

9.26 FIFO_STATUS2 (1Ch)

FIFO status register 2 (R)

Table 78. FIFO_STATUS2 register

FIFO_ WTM_IA	FIFO_ OVR_IA	FIFO_ FULL_IA	COUNTER_ BDR_IA	FIFO_OVR_ LATCHED	0	0	DIFF_ FIFO_8

Table 79. FIFO_STATUS2 register description

FIFO_WTM_IA	FIFO watermark status. Default value: 0 (0: FIFO filling is lower than WTM; 1: FIFO filling is equal to or greater than WTM) Watermark is set through bits WTM[7:0] in FIFO_CTRL2 (08h) and FIFO_CTRL1 (07h).
FIFO_OVR_IA	FIFO overrun status. Default value: 0 (0: FIFO is not completely filled; 1: FIFO is completely filled)
FIFO_FULL_IA	Smart FIFO full status. Default value: 0 (0: FIFO is not full; 1: FIFO will be full at the next ODR)
COUNTER_BDR_IA	Counter BDR reaches the CNT_BDR_TH_[10:0] threshold set in COUNTER_BDR_REG1 (0Bh) and COUNTER_BDR_REG2 (0Ch). Default value: 0 This bit is reset when these registers are read.
FIFO_OVR_LATCHED	Latched FIFO overrun status. Default value: 0 This bit is reset when this register is read.
DIFF_FIFO_8	Number of unread sensor data (TAG + 6 bytes) stored in FIFO. Default value: 00 In conjunction with DIFF_FIFO[7:0] in FIFO_STATUS1 (1Bh)

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9.27 ALL_INT_SRC (1Dh)

Source register for all interrupts (R)

Table 80. ALL_INT_SRC register

EMB_ FUNC_IA	SHUB_IA	SLEEP_ CHANGE_IA	D6D_IA	0	TAP_IA	WU_IA	FF_IA

Table 81. ALL_INT_SRC register description

EMB_FUNC_IA	Embedded functions interrupt status. Default value: 0 (0: embedded functions event not detected; 1: embedded functions event detected)
SHUB_IA	Sensor hub (I²C master) interrupt status. Default value: 0 (0: sensor hub interrupt not generated; 1: sensor hub interrupt generated)
SLEEP_CHANGE_IA	Detects change event in activity/inactivity status. Default value: 0 (0: change status not detected; 1: change status detected)
D6D_IA	Interrupt active for change in position of portrait, landscape, face-up, face-down. Default value: 0 (0: change in position not detected; 1: change in position detected)
TAP_IA	Single or double-tap event detection status depending on SINGLE_DOUBLE_TAP_bit value (see WAKE_UP_THS (5Bh) register). Default value: 0 (0: tap event not detected; 1: tap event detected)
WU_IA	Wake-up event status. Default value: 0 (0: event not detected, 1: event detected)
FF_IA	Free-fall event status. Default value: 0 (0: event not detected, 1: event detected)

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9.28 STATUS_REG (1Eh)

The STATUS_REG register is read by the primary interface SPI/I²C & MIPI I3C® (R).

Table 82. STATUS_REG register

TIMESTAMP_ ENDCOUNT	0	OIS_DRDY	GDA_EIS	AH_QVARDA	TDA	GDA	XLDA

Table 83. STATUS_REG register description

TIMESTAMP_ENDCOUNT	Alerts timestamp overflow within 5.6 ms
OIS_DRDY	Accelerometer OIS or gyroscope OIS new output data available. Default value: 0 (0: no set of data (accelerometer or gyroscope) available on OIS chain; 1: a new set of data (accelerometer or gyroscope) is available on OIS chain)
GDA_EIS	Enhanced EIS gyroscope new data available. Default value: 0 (0: no set of data available at gyroscope output; 1: a new set of data is available at gyroscope output)
AH_QVARDA	Analog hub or Qvar new data available. Default value: 0 (0: no set of data available at the analog hub or Qvar data output; 1: a new set of data is available at the analog hub or Qvar data output)
TDA	Temperature new data available. Default: 0 (0: no set of data is available at temperature sensor output; 1: a new set of data is available at temperature sensor output)
GDA	Gyroscope new data available. Default value: 0 (0: no set of data available at gyroscope output; 1: a new set of data is available at gyroscope output)
XLDA	Accelerometer new data available. Default value: 0 (0: no set of data available at accelerometer output; 1: a new set of data is available at accelerometer output)

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9.29 OUT_TEMP_L (20h), OUT_TEMP_H (21h)

Temperature data output register (R). L and H registers together express a 16-bit word in two’s complement.

Table 84. OUT_TEMP_L register

Temp7	Temp6	Temp5	Temp4	Temp3	Temp2	Temp1	Temp0

Table 85. OUT_TEMP_H register

Temp15	Temp14	Temp13	Temp12	Temp11	Temp10	Temp9	Temp8

Table 86. OUT_TEMP register description

Temp[15:0]	Temperature sensor output data The value is expressed in two's complement.

9.30 OUTX_L_G (22h) and OUTX_H_G (23h)

Angular rate sensor pitch axis (X) angular rate output register (R). The value is expressed as a 16-bit word in two’s complement.

Data are according to the full-scale (CTRL6 (15h)) and ODR settings (CTRL2 (11h)) of the gyroscope user interface.

Table 87. OUTX_L_G register

D7	D6	D5	D4	D3	D2	D1	D0

Table 88. OUTX_H_G register

D15	D14	D13	D12	D11	D10	D9	D8

Table 89. OUTX_G register description

D[15:0]	Gyroscope UI chain pitch axis (X) angular rate output value

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9.31 OUTY_L_G (24h) and OUTY_H_G (25h)

Angular rate sensor roll axis (Y) angular rate output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the full-scale (CTRL6 (15h)) and ODR settings (CTRL2 (11h)) of the gyroscope user interface.

Table 90. OUTY_L_G register

D7	D6	D5	D4	D3	D2	D1	D0

Table 91. OUTY_H_G register

D15	D14	D13	D12	D11	D10	D9	D8

Table 92. OUTY_G register description

D[15:0]	Gyroscope UI chain roll axis (Y) angular rate output value

9.32 OUTZ_L_G (26h) and OUTZ_H_G (27h)

Angular rate sensor yaw axis (Z) angular rate output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the full-scale (CTRL6 (15h)) and ODR settings (CTRL2 (11h)) of the gyroscope user interface.

Table 93. OUTZ_L_G register

D7	D6	D5	D4	D3	D2	D1	D0

Table 94. OUTZ_H_G register

D15	D14	D13	D12	D11	D10	D9	D8

Table 95. OUTZ_H_G register description

D[15:0]	Gyroscope UI chain yaw axis (Z) angular rate output value

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9.33 OUTX_L_A (28h) and OUTX_H_A (29h)

Linear acceleration sensor X-axis output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the full-scale (CTRL8 (17h)) and ODR settings (CTRL1 (10h)) of the accelerometer user interface.

Table 96. OUTX_L_A register

D7	D6	D5	D4	D3	D2	D1	D0

Table 97. OUTX_H_A register

D15	D14	D13	D12	D11	D10	D9	D8

Table 98. OUTX_A register description

D[15:0]	Accelerometer UI chain X-axis linear acceleration output value

9.34 OUTY_L_A (2Ah) and OUTY_H_A (2Bh)

Linear acceleration sensor Y-axis output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the full-scale (CTRL8 (17h)) and ODR settings (CTRL1 (10h)) of the accelerometer user interface.

Table 99. OUTY_L_A register

D7	D6	D5	D4	D3	D2	D1	D0

Table 100. OUTY_H_A register

D15	D14	D13	D12	D11	D10	D9	D8

Table 101. OUTY_A register description

D[15:0]	Accelerometer UI chain Y-axis linear acceleration output value

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9.35 OUTZ_L_A (2Ch) and OUTZ_H_A (2Dh)

Linear acceleration sensor Z-axis output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the full-scale (CTRL8 (17h)) and ODR settings (CTRL1 (10h)) of the accelerometer user interface.

Table 102. OUTZ_L_A register

D7	D6	D5	D4	D3	D2	D1	D0

Table 103. OUTZ_H_A register

D15	D14	D13	D12	D11	D10	D9	D8

Table 104. OUTZ_A register description

D[15:0]	Accelerometer UI chain Z-axis linear acceleration output value

9.36 UI_OUTX_L_G_OIS_EIS (2Eh) and UI_OUTX_H_G_OIS_EIS (2Fh)

Angular rate sensor pitch axis (X) angular rate output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the gyroscope full-scale and ODR settings of the OIS gyroscope or the EIS gyroscope channel.

Table 105. UI_OUTX_L_G_OIS_EIS register

D7	D6	D5	D4	D3	D2	D1	D0

Table 106. UI_OUTX_H_G_OIS_EIS register

D15	D14	D13	D12	D11	D10	D9	D8

Table 107. UI_OUTX_G_OIS_EIS register description

D[15:0]	Gyroscope pitch axis OIS/EIS output expressed in two's complement

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9.37 UI_OUTY_L_G_OIS_EIS (30h) and UI_OUTY_H_G_OIS_EIS (31h)

Angular rate sensor roll axis (Y) angular rate output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the gyroscope full-scale and ODR settings of the OIS gyroscope or the EIS gyroscope channel.

Table 108. UI_OUTY_L_G_OIS_EIS register

D7	D6	D5	D4	D3	D2	D1	D0

Table 109. UI_OUTY_H_G_OIS_EIS register

D15	D14	D13	D12	D11	D10	D9	D8

Table 110. UI_OUTY_G_OIS_EIS register description

D[15:0]	Gyroscope roll axis OIS/EIS output expressed in two's complement

9.38 UI_OUTZ_L_G_OIS_EIS (32h) and UI_OUTZ_H_G_OIS_EIS (33h)

Angular rate sensor yaw axis (Z) angular rate output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the gyroscope full-scale and ODR settings of the OIS gyroscope or the EIS gyroscope channel.

Table 111. UI_OUTZ_L_G_OIS_EIS register

D7	D6	D5	D4	D3	D2	D1	D0

Table 112. UI_OUTZ_H_G_OIS_EIS register

D15	D14	D13	D12	D11	D10	D9	D8

Table 113. UI_OUTZ_G_OIS_EIS register description

D[15:0]	Gyroscope yaw axis OIS/EIS output expressed in two's complement

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9.39 UI_OUTX_L_A_OIS_DualC (34h) and UI_OUTX_H_A_OIS_DualC (35h)

Linear acceleration sensor X-axis output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the accelerometer full-scale and ODR settings of the OIS accelerometer or according to the accelerometer dual-channel mode configuration.

Table 114. UI_OUTX_L_A_OIS_DualC register

D7	D6	D5	D4	D3	D2	D1	D0

Table 115. UI_OUTX_H_A_OIS_DualC register

D15	D14	D13	D12	D11	D10	D9	D8

Table 116. UI_OUTX_A_OIS_DualC register description

D[15:0]	Accelerometer X-axis OIS/DualC output expressed in two's complement

9.40 UI_OUTY_L_A_OIS_DualC (36h) and UI_OUTY_H_A_OIS_DualC (37h)

Linear acceleration sensor Y-axis output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the accelerometer full-scale and ODR settings of the OIS accelerometer or according to the accelerometer dual-channel mode configuration.

Table 117. UI_OUTY_L_A_OIS_DualC register

D7	D6	D5	D4	D3	D2	D1	D0

Table 118. UI_OUTY_H_A_OIS_DualC register

D15	D14	D13	D12	D11	D10	D9	D8

Table 119. UI_OUTY_A_OIS_DualC register description

D[15:0]	Accelerometer Y-axis OIS/DualC output expressed in two's complement

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9.41 UI_OUTZ_L_A_OIS_DualC (38h) and UI_OUTZ_H_A_OIS_DualC (39h)

Linear acceleration sensor Z-axis output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the accelerometer full-scale and ODR settings of the OIS accelerometer or according to the accelerometer dual-channel mode configuration.

Table 120. UI_OUTZ_L_A_OIS_DualC register

D7	D6	D5	D4	D3	D2	D1	D0

Table 121. UI_OUTZ_H_A_OIS_DualC register

D15	D14	D13	D12	D11	D10	D9	D8

Table 122. UI_OUTZ_A_OIS_DualC register description

D[15:0]	Accelerometer Z-axis OIS/DualC output expressed in two's complement

9.42 AH_QVAR_OUT_L (3Ah) and AH_QVAR_OUT_H (3Bh)

Analog hub and Qvar data output register (R). L and H registers together express a 16-bit word in two's complement.

Table 123. AH_QVAR_OUT_L register

AH_Qvar_7	AH_Qvar_6	AH_Qvar_5	AH_Qvar_4	AH_Qvar_3	AH_Qvar_2	AH_Qvar_1	AH_Qvar_0

Table 124. AH_QVAR_OUT_H register

AH_Qvar_15	AH_Qvar_14	AH_Qvar_13	AH_Qvar_12	AH_Qvar_11	AH_Qvar_10	AH_Qvar_9	AH_Qvar_8

Table 125. AH_QVAR_OUT register description

AH_Qvar_[15:0]	When the analog hub or Qvar is enabled (by setting the AH_QVAR_EN bit to 1 in CTRL7 (16h)), these registers contain the analog hub or the Qvar sensor ouput data. Data are expressed in two's complement.

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9.43 TIMESTAMP0 (40h), TIMESTAMP1 (41h), TIMESTAMP2 (42h), and TIMESTAMP3 (43h)

Timestamp first data output register (R). The value is expressed as a 32-bit word and the bit resolution is 21.75 µs (typical).

Table 126. TIMESTAMP output registers

D31	D30	D29	D28	D27	D26	D25	D24
D23	D22	D21	D20	D19	D18	D17	D16
D15	D14	D13	D12	D11	D10	D9	D8
D7	D6	D5	D4	D3	D2	D1	D0

Table 127. TIMESTAMP output register description

D[31:0]	Timestamp output registers: 1LSB = 21.75 µs (typical)

9.44 UI_STATUS_REG_OIS (44h)

Table 128. UI_STATUS_REG_OIS register

0	0	0	0	0	GYRO_ SETTLING	GDA_OIS	XLDA_OIS

Table 129. UI_STATUS_REG_OIS register description

GYRO_SETTLING	High when the gyroscope output is in the settling phase
GDA_OIS	Gyroscope OIS data available (reset when one of the high parts of the output data is read). Default value: 0 (0: no set of data available at gyroscope OIS output; 1: a new set of data is available at gyroscope output)
XLDA_OIS	Accelerometer OIS data available (reset when one of the high parts of the output data is read). Default value: 0 (0: no set of data available at gyroscope OIS output; 1: a new set of data is available at gyroscope output)

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9.45 WAKE_UP_SRC (45h)

Wake-up interrupt source register (R)

Table 130. WAKE_UP_SRC register

0	SLEEP_ CHANGE_IA	FF_IA	SLEEP_ STATE	WU_IA	X_WU	Y_WU	Z_WU

Table 131. WAKE_UP_SRC register description

SLEEP_CHANGE_IA	Detects change event in activity/inactivity status. Default value: 0 (0: change status not detected; 1: change status detected)
FF_IA	Free-fall event detection status. Default: 0 (0: free-fall event not detected; 1: free-fall event detected)
SLEEP_STATE	Sleep status bit. Default value: 0 (0: Activity status; 1: Inactivity status)
WU_IA	Wake-up event detection status. Default value: 0 (0: wake-up event not detected; 1: wake-up event detected.)
X_WU	Wake-up event detection status on X-axis. Default value: 0 (0: wake-up event on X-axis not detected; 1: wake-up event on X-axis detected)
Y_WU	Wake-up event detection status on Y-axis. Default value: 0 (0: wake-up event on Y-axis not detected; 1: wake-up event on Y-axis detected)
Z_WU	Wake-up event detection status on Z-axis. Default value: 0 (0: wake-up event on Z-axis not detected; 1: wake-up event on Z-axis detected)

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9.46 TAP_SRC (46h)

Tap source register (R)

Table 132. TAP_SRC register

0	TAP_IA	SINGLE_ TAP	DOUBLE_ TAP	TAP_SIGN	X_TAP	Y_TAP	Z_TAP

Table 133. TAP_SRC register description

TAP_IA	Tap event detection status. Default: 0 (0: tap event not detected; 1: tap event detected)
SINGLE_TAP	Single-tap event status. Default value: 0 (0: single tap event not detected; 1: single tap event detected)
DOUBLE_TAP	Double-tap event detection status. Default value: 0 (0: double-tap event not detected; 1: double-tap event detected.)
TAP_SIGN	Sign of acceleration detected by tap event. Default: 0 (0: positive sign of acceleration detected by tap event; 1: negative sign of acceleration detected by tap event)
X_TAP	Tap event detection status on X-axis. Default value: 0 (0: tap event on X-axis not detected; 1: tap event on X-axis detected)
Y_TAP	Tap event detection status on Y-axis. Default value: 0 (0: tap event on Y-axis not detected; 1: tap event on Y-axis detected)
Z_TAP	Tap event detection status on Z-axis. Default value: 0 (0: tap event on Z-axis not detected; 1: tap event on Z-axis detected)

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9.47 D6D_SRC (47h)

Portrait, landscape, face-up and face-down source register (R)

Table 134. D6D_SRC register

0	D6D_IA	ZH	ZL	YH	YL	XH	XL

Table 135. D6D_SRC register description

D6D_IA	Interrupt active for change position portrait, landscape, face-up, face-down. Default value: 0 (0: change position not detected; 1: change position detected)
ZH	Z-axis high event (over threshold). Default value: 0 (0: event not detected; 1: event (over threshold) detected)
ZL	Z-axis low event (under threshold). Default value: 0 (0: event not detected; 1: event (under threshold) detected)
YH	Y-axis high event (over threshold). Default value: 0 (0: event not detected; 1: event (over-threshold) detected)
YL	Y-axis low event (under threshold). Default value: 0 (0: event not detected; 1: event (under threshold) detected)
XH	X-axis high event (over threshold). Default value: 0 (0: event not detected; 1: event (over threshold) detected)
XL	X-axis low event (under threshold). Default value: 0 (0: event not detected; 1: event (under threshold) detected)

9.48 STATUS_MASTER_MAINPAGE (48h)

Sensor hub source register (R)

Table 136. STATUS_MASTER_MAINPAGE register

WR_ONCE_DONE	SLAVE3_NACK	SLAVE2_NACK	SLAVE1_NACK	SLAVE0_NACK	0	0	SENS_HUB_ENDOP

Table 137. STATUS_MASTER_MAINPAGE register description

WR_ONCE_DONE	When the bit WRITE_ONCE in MASTER_CONFIG (14h) is configured as 1, this bit is set to 1 when the write operation on slave 0 has been performed and completed. Default value: 0
SLAVE3_NACK	This bit is set to 1 if Not acknowledge occurs on slave 3 communication. Default value: 0
SLAVE2_NACK	This bit is set to 1 if Not acknowledge occurs on slave 2 communication. Default value: 0
SLAVE1_NACK	This bit is set to 1 if Not acknowledge occurs on slave 1 communication. Default value: 0
SLAVE0_NACK	This bit is set to 1 if Not acknowledge occurs on slave 0 communication. Default value: 0
SENS_HUB_ENDOP	Sensor hub communication status. Default value: 0 (0: sensor hub communication not concluded; 1: sensor hub communication concluded)

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9.49 EMB_FUNC_STATUS_MAINPAGE (49h)

Embedded function status register (R)

Table 138. EMB_FUNC_STATUS_MAINPAGE register

IS_FSM_LC	0	IS_ SIGMOT	IS_TILT	IS_ STEP_DET	0	0	0

Table 139. EMB_FUNC_STATUS_MAINPAGE register description

IS_FSM_LC	Interrupt status bit for FSM long counter timeout interrupt event. (1: interrupt detected; 0: no interrupt)
IS_SIGMOT	Interrupt status bit for significant motion detection (1: interrupt detected; 0: no interrupt)
IS_TILT	Interrupt status bit for tilt detection (1: interrupt detected; 0: no interrupt)
IS_STEP_DET	Interrupt status bit for step detection (1: interrupt detected; 0: no interrupt)

9.50 FSM_STATUS_MAINPAGE (4Ah)

Finite state machine status register (R)

Table 140. FSM_STATUS_MAINPAGE register

IS_FSM8	IS_FSM7	IS_FSM6	IS_FSM5	IS_FSM4	IS_FSM3	IS_FSM2	IS_FSM1

Table 141. FSM_STATUS_MAINPAGE register description

IS_FSM8	Interrupt status bit for FSM8 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM7	Interrupt status bit for FSM7 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM6	Interrupt status bit for FSM6 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM5	Interrupt status bit for FSM5 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM4	Interrupt status bit for FSM4 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM3	Interrupt status bit for FSM3 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM2	Interrupt status bit for FSM2 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM1	Interrupt status bit for FSM1 interrupt event. (1: interrupt detected; 0: no interrupt)

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9.51 MLC_STATUS_MAINPAGE (4Bh)

Machine learning core status register (R)

Table 142. MLC_STATUS _MAINPAGE register

0	0	0	0	IS_MLC4	IS_MLC3	IS_MLC2	IS_MLC1

Table 143. MLC_STATUS_MAINPAGE register description

IS_MLC4	Interrupt status bit for MLC4 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_MLC3	Interrupt status bit for MLC3 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_MLC2	Interrupt status bit for MLC2 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_MLC1	Interrupt status bit for MLC1 interrupt event. (1: interrupt detected; 0: no interrupt)

9.52 INTERNAL_FREQ_FINE (4Fh)

Internal frequency register (R)

Table 144. INTERNAL_FREQ_FINE register

FREQ_ FINE_7	FREQ_ FINE_6	FREQ_ FINE_5	FREQ_ FINE_4	FREQ_ FINE_3	FREQ_ FINE_2	FREQ_ FINE_1	FREQ_ FINE_0

Table 145. INTERNAL_FREQ_FINE register description

FREQ_FINE_[7:0]	Difference in percentage of the effective ODR (and timestamp rate) with respect to the typical. Step: 0.13%. 8-bit format, two's complement.

The actual timestamp resolution and the actual output data rate can be calculated using the following formulas:

$$t_{actual}[s] = \frac{1}{46080 \cdot (1 + 0.0013 \cdot FREQ_FINE)}$$

$$ODR_{actual}[Hz] = \frac{7680 \cdot (1 + 0.0013 \cdot FREQ_FINE)}{ODR_{coeff}}$$

Table 146. ODR_{coeff} values

Selected ODR [Hz]	ODRcoeff
7.5	1024
15	512
30	256
60	128
120	64
240	32
480	16
960	8
1.92 kHz	4
3.84 kHz	2
7.68 kHz	1

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9.53 FUNCTIONS_ENABLE (50h)

Enable interrupt functions register (R/W)

Table 147. FUNCTIONS_ENABLE register

INTERRUPTS_ENABLE	TIMESTAMP_EN	0(1)	0(1)	DIS_RST_LIR_ALL_INT	0(1)	INACT_EN_1	INACT_EN_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 148. FUNCTIONS_ENABLE register description

INTERRUPTS_ENABLE	Enables basic interrupts (6D/4D, free-fall, wake-up, tap, activity/inactivity). Default value: 0 (0: interrupt disabled; 1: interrupt enabled)
TIMESTAMP_EN	Enables timestamp counter. The counter is readable in TIMESTAMP0 (40h), TIMESTAMP1 (41h), TIMESTAMP2 (42h), and TIMESTAMP3 (43h). Default value: 0 (0: disabled; 1: enabled)
DIS_RST_LIR_ALL_INT	When this bit is set to 1, reading the ALL_INT_SRC (1Dh) register does not reset the latched interrupt signals. This can be useful in order to not reset some status flags before reading the corresponding status register. Default value: 0 (0: disabled; 1: enabled)
INACT_EN_[1:0]	Enables activity/inactivity (sleep) function. Default value: 00 (00: stationary/motion-only interrupts generated, accelerometer and gyroscope configuration do not change; 01: sets accelerometer to low-power mode 1 with accelerometer ODR selected through the XL_INACT_ODR_[1:0] bits of the INACTIVITY_DUR (54h) register, gyroscope configuration does not change; 10: sets accelerometer to low-power mode 1 with accelerometer ODR selected through the XL_INACT_ODR_[1:0] bits of the INACTIVITY_DUR (54h) register, gyroscope in sleep mode; 11: sets accelerometer to low-power mode 1 with accelerometer ODR selected through the XL_INACT_ODR_[1:0] bits of the INACTIVITY_DUR (54h) register, gyroscope in power-down mode)

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9.54 DEN (51h)

DEN configuration register (R/W)

Table 149. DEN register

0(1)	LVL1_EN	LVL2_EN	DEN_XL_EN	DEN_X	DEN_Y	DEN_Z	DEN_XL_G

1. *This bit must be set to 0 for the correct operation of the device.*

Table 150. DEN register description

LVL1_EN	Enables DEN data level-sensitive trigger. Refer to Table 151.
LVL2_EN	Enables DEN level-sensitive latched. Refer to Table 151.
DEN_XL_EN	Extends DEN functionality to accelerometer sensor. Default value: 0 (0: disabled; 1: enabled)
DEN_X	DEN value stored in LSB of X-axis. Default value: 1 (0: DEN not stored in X-axis LSB; 1: DEN stored in X-axis LSB)
DEN_Y	DEN value stored in LSB of Y-axis. Default value: 1 (0: DEN not stored in Y-axis LSB; 1: DEN stored in Y-axis LSB)
DEN_Z	DEN value stored in LSB of Z-axis. Default value: 1 (0: DEN not stored in Z-axis LSB; 1: DEN stored in Z-axis LSB)
DEN_XL_G	DEN stamping sensor selection. Default value: 0 (0: DEN pin info stamped in the gyroscope axis selected by bits DEN_X, DEN_Y, DEN_Z; 1: DEN pin info stamped in the accelerometer axis selected by bits DEN_X, DEN_Y, DEN_Z)

Table 151. Trigger mode selection

LVL1_EN, LVL2_EN	Trigger mode
10	Level-sensitive trigger mode is selected
11	Level-sensitive latched mode is selected

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9.55 INACTIVITY_DUR (54h)

Activity/inactivity configuration register (R/W)

Table 152. INACTIVITY_DUR register

SLEEP_STATUS_ON_INT	WU_INACT_THS_W_2	WU_INACT_THS_W_1	WU_INACT_THS_W_0	XL_INACT_ODR_1	XL_INACT_ODR_0	INACT_DUR_1	INACT_DUR_0

Table 153. INACTIVITY_DUR register description

SLEEP_STATUS_ON_INT	Activity/inactivity interrupt mode configuration. If the INT1_SLEEP_CHANGE or INT2_SLEEP_CHANGE bit is enabled, drives the sleep status or sleep change on the INT pin. Default value: 0 (0: sleep change notification on INT pin; 1: sleep status reported on INT pin)
WU_INACT_THS_W_[2:0]	Weight of 1 LSB of wake-up (WU_THS) and activity/inactivity (INACT_THS) threshold. (000: 7.8125 mg/LSB (default); 001: 15.625 mg/LSB; 010: 31.25 mg/LSB; 011: 62.5 mg/LSB; 100: 125 mg/LSB; 101 - 110 - 111: 250 mg/LSB)
XL_INACT_ODR_[1:0]	Selects the ODR_XL target during inactivity. (00: 1.875 Hz; 01: 15 Hz (default); 10: 30 Hz; 11: 60 Hz)
INACT_DUR_[1:0]	Duration in the transition from stationary to motion (from inactivity to activity). (00: transition to motion (activity) immediately at first overthreshold event (default); 01: transition to motion (activity) after two consecutive overthreshold events; 10: transition to motion (activity) after three consecutive overthreshold events; 11: transition to motion (activity) after four consecutive overthreshold events)

9.56 INACTIVITY_THS (55h)

Activity/inactivity threshold setting register (R/W)

Table 154. INACTIVITY_THS register

0(1)	0(1)	INACT_THS_5	INACT_THS_4	INACT_THS_3	INACT_THS_2	INACT_THS_1	INACT_THS_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 155. INACTIVITY_THS register description

INACT_THS_[5:0]	Activity/inactivity threshold. The resolution of the threshold depends on the value of WU_INACT_THS_W_[2:0] in the INACTIVITY_DUR (54h) register. Default value: 000000

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9.57 TAP_CFG0 (56h)

Tap configuration register 0 (R/W)

Table 156. TAP_CFG0 register

0[1]	LOW_PASS_ON_6D	HW_FUNC_MASK_XL_SETTL	SLOPE_FDS	TAP_X_EN	TAP_Y_EN	TAP_Z_EN	LIR

1. *This bit must be set to 0 for the correct operation of the device.*

Table 157. TAP_CFG0 register description

LOW_PASS_ON_6D	LPF2 filter on 6D function selection. Refer to Figure 32. Default value: 0 (0: ODR/2 low-pass filtered data sent to 6D interrupt function; 1: LPF2 output data sent to 6D interrupt function)
HW_FUNC_MASK_XL_SETTL	Enables masking the execution trigger of the basic interrupt functions (6D/4D, free-fall, wake-up, tap, activity/inactivity) when accelerometer data are settling. Default value: 0 (0: disabled; 1: enabled) *Note: Refer to the product application note for the details regarding operating/power mode configurations, settings, turn-on/off time and on-the-fly changes.*
SLOPE_FDS	HPF or slope filter selection on wake-up and activity/inactivity functions. Refer to Figure 32. Default value: 0 (0: slope filter applied; 1: HPF applied)
TAP_X_EN	Enables X direction in tap recognition. Default value: 0 (0: X direction disabled; 1: X direction enabled)
TAP_Y_EN	Enables Y direction in tap recognition. Default value: 0 (0: Y direction disabled; 1: Y direction enabled)
TAP_Z_EN	Enables Z direction in tap recognition. Default value: 0 (0: Z direction disabled; 1: Z direction enabled)
LIR	Latched interrupt. Default value: 0 (0: interrupt request not latched; 1: interrupt request latched)

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9.58 TAP_CFG1 (57h)

Tap configuration register 1 (R/W)

Table 158. TAP_CFG1 register

TAP_ PRIORITY_2	TAP_ PRIORITY_1	TAP_ PRIORITY_0	TAP_ THS_X_4	TAP_ THS_X_3	TAP_ THS_X_2	TAP_ THS_X_1	TAP_ THS_X_0

Table 159. TAP_CFG1 register description

TAP_PRIORITY_[2:0]	Selection of axis priority for tap detection (see Table 160)
TAP_THS_X_[4:0]	X-axis tap recognition threshold. Default value: 0 1 LSB = FS_XL / (2^5)

Table 160. TAP priority decoding

TAP_PRIORITY_[2:0]	Max. priority	Mid. priority	Min. priority
000	X	Y	Z
001	Y	X	Z
010	X	Z	Y
011	Z	Y	X
100	X	Y	Z
101	Y	Z	X
110	Z	X	Y
111	Z	Y	X

9.59 TAP_CFG2 (58h)

Tap configuration register 2 (R/W)

Table 161. TAP_CFG2 register

0(1)	0(1)	0(1)	TAP_ THS_Y_4	TAP_ THS_Y_3	TAP_ THS_Y_2	TAP_ THS_Y_1	TAP_ THS_Y_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 162. TAP_CFG2 register description

TAP_THS_Y_[4:0]	Y-axis tap recognition threshold. Default value: 0 1 LSB = FS_XL / (2^5)

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9.60 TAP_THS_6D (59h)

Portrait/landscape position and tap function threshold register (R/W)

Table 163. TAP_THS_6D register

D4D_EN	SIXD_THS_1	SIXD_THS_0	TAP_ THS_Z_4	TAP_ THS_Z_3	TAP_ THS_Z_2	TAP_ THS_Z_1	TAP_ THS_Z_0

Table 164. TAP_THS_6D register description

D4D_EN	Enables 4D orientation detection. Z-axis position detection is disabled. Default value: 0 (0: disabled; 1: enabled)
SIXD_THS_[1:0]	Threshold for 4D/6D function. Default value: 00 For details, refer to Table 165.
TAP_THS_Z_[4:0]	Z-axis recognition threshold. Default value: 0 1 LSB = FS_XL / (2^5)

Table 165. Threshold for D4D/D6D function

SIXD_THS_[1:0]	Threshold value
00	80 degrees
01	70 degrees
10	60 degrees
11	50 degrees

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9.61 TAP_DUR (5Ah)

Tap recognition function setting register (R/W)

Table 166. TAP_DUR register

DUR_3	DUR_2	DUR_1	DUR_0	QUIET_1	QUIET_0	SHOCK_1	SHOCK_0

Table 167. TAP_DUR register description

DUR_[3:0]	Duration of maximum time gap for double-tap recognition. Default: 0000 When double-tap recognition is enabled, this register expresses the maximum time between two consecutive detected taps to determine a double-tap event. The default value of these bits is 0000b which corresponds to 16/ODR_XL time. If the DUR_[3:0] bits are set to a different value, 1LSB corresponds to 32/ODR_XL time.
QUIET_[1:0]	Expected quiet time after a tap detection. Default value: 00 Quiet time is the time after the first detected tap in which there must not be any overthreshold event. The default value of these bits is 00b which corresponds to 2/ODR_XL time. If the QUIET_[1:0] bits are set to a different value, 1LSB corresponds to 4/ODR_XL time.
SHOCK_[1:0]	Maximum duration of overthreshold event. Default value: 00 Maximum duration is the maximum time of an overthreshold signal detection to be recognized as a tap event. The default value of these bits is 00b which corresponds to 4/ODR_XL time. If the SHOCK_[1:0] bits are set to a different value, 1LSB corresponds to 8/ODR_XL time.

9.62 WAKE_UP_THS (5Bh)

Single/double-tap selection and wake-up configuration (R/W)

Table 168. WAKE_UP_THS register

SINGLE_ DOUBLE_TAP	USR_OFF _ON_WU	WK_THS_5	WK_THS_4	WK_THS_3	WK_THS_2	WK_THS_1	WK_THS_0

Table 169. WAKE_UP_THS register description

SINGLE_DOUBLE_TAP	Enables single/double-tap event. Default value: 0 (0: only single-tap event enabled; 1: both single and double-tap events enabled)
USR_OFF_ON_WU	Drives the low-pass filtered data with user offset correction (instead of high-pass filtered data) to the wake-up and the activity/inactivity functions. Refer to Figure 32. Default value: 0
WK_THS_[5:0]	Wake-up threshold. The resolution of the threshold depends on the value of WU_INACT_THS_W_[2:0] in the INACTIVITY_DUR (54h) register. Default value: 000000

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9.63 WAKE_UP_DUR (5Ch)

Free-fall, wake-up, and sleep mode functions duration setting register (R/W)

Table 170. WAKE_UP_DUR register

FF_DUR_5	WAKE_DUR_1	WAKE_DUR_0	0(1)	SLEEP_DUR_3	SLEEP_DUR_2	SLEEP_DUR_1	SLEEP_DUR_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 171. WAKE_UP_DUR register description

FF_DUR_5	Free-fall duration event. Default: 0 For the complete configuration of the free-fall duration, refer to FF_DUR_[4:0] in the FREE_FALL (5Dh) configuration. 1 LSB = 1/ODR_XL time
WAKE_DUR_[1:0]	Wake-up duration event. Default: 00 1 LSB = 1/ODR_XL time
SLEEP_DUR_[3:0]	Duration to go in sleep mode. Default value: 0000 (this corresponds to 16 ODR) 1 LSB = 512/ODR_XL time

9.64 FREE_FALL (5Dh)

Free-fall function duration setting register (R/W)

Table 172. FREE_FALL register

FF_DUR_4	FF_DUR_3	FF_DUR_2	FF_DUR_1	FF_DUR_0	FF_THS_2	FF_THS_1	FF_THS_0

Table 173. FREE_FALL register description

FF_DUR_[4:0]	Free-fall duration event. Default: 00000 For the complete configuration of the free-fall duration, refer to FF_DUR_5 in the WAKE_UP_DUR (5Ch) configuration.
FF_THS_[2:0]	Free-fall threshold setting. Default: 000 For details refer to Table 174.

Table 174. Threshold for free-fall function

FF_THS_[2:0]	Threshold value
000	156 mg
001	219 mg
010	250 mg
011	312 mg
100	344 mg
101	406 mg
110	469 mg
111	500 mg

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9.65 MD1_CFG (5Eh)

Functions routing to INT1 pin register (R/W). Each bit in this register enables a signal to be carried over the INT1 pin. The output of the pin is the OR combination of the signals selected here and in the INT1_CTRL (0Dh) register.

Table 175. MD1_CFG register

INT1_SLEEP_CHANGE	INT1_SINGLE_TAP	INT1_WU	INT1_FF	INT1_DOUBLE_TAP	INT1_6D	INT1_EMB_FUNC	INT1_SHUB

Table 176. MD1_CFG register description

INT1_SLEEP_CHANGE[1]	Routing activity/inactivity recognition event to INT1. Default: 0 (0: routing activity/inactivity event to INT1 disabled; 1: routing activity/inactivity event to INT1 enabled)
INT1_SINGLE_TAP	Routing single-tap recognition event to INT1. Default: 0 (0: routing single-tap event to INT1 disabled; 1: routing single-tap event to INT1 enabled)
INT1_WU	Routing wake-up event to INT1. Default value: 0 (0: routing wake-up event to INT1 disabled; 1: routing wake-up event to INT1 enabled)
INT1_FF	Routing free-fall event to INT1. Default value: 0 (0: routing free-fall event to INT1 disabled; 1: routing free-fall event to INT1 enabled)
INT1_DOUBLE_TAP	Routing tap event to INT1. Default value: 0 (0: routing double-tap event to INT1 disabled; 1: routing double-tap event to INT1 enabled)
INT1_6D	Routing 6D event to INT1. Default value: 0 (0: routing 6D event to INT1 disabled; 1: routing 6D event to INT1 enabled)
INT1_EMB_FUNC	Routing embedded functions event to INT1. Default value: 0 (0: routing embedded functions event to INT1 disabled; 1: routing embedded functions event to INT1 enabled)
INT1_SHUB	Routing sensor hub communication concluded event to INT1. Default value: 0 (0: routing sensor hub communication concluded event to INT1 disabled; 1: routing sensor hub communication concluded event to INT1 enabled)

1. *Activity/inactivity interrupt mode (sleep change or sleep status) depends on the SLEEP_STATUS_ON_INT bit in the INACTIVITY_DUR (54h) register.*

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9.66 MD2_CFG (5Fh)

Functions routing to INT2 pin register (R/W). Each bit in this register enables a signal to be carried over the INT2 pin. The output of the pin is the OR combination of the signals selected here and in the INT2_CTRL (0Eh) register.

Table 177. MD2_CFG register

INT2_SLEEP_CHANGE	INT2_SINGLE_TAP	INT2_WU	INT2_FF	INT2_DOUBLE_TAP	INT2_6D	INT2_EMB_FUNC	INT2_TIMESTAMP

Table 178. MD2_CFG register description

INT2_SLEEP_CHANGE(1)	Routing activity/inactivity recognition event to INT2. Default: 0 (0: routing activity/inactivity event to INT2 disabled; 1: routing activity/inactivity event to INT2 enabled)
INT2_SINGLE_TAP	Single-tap recognition routing to INT2. Default: 0 (0: routing single-tap event to INT2 disabled; 1: routing single-tap event to INT2 enabled)
INT2_WU	Routing wake-up event to INT2. Default value: 0 (0: routing wake-up event to INT2 disabled; 1: routing wake-up event to INT2 enabled)
INT2_FF	Routing free-fall event to INT2. Default value: 0 (0: routing free-fall event to INT2 disabled; 1: routing free-fall event to INT2 enabled)
INT2_DOUBLE_TAP	Routing tap event to INT2. Default value: 0 (0: routing double-tap event to INT2 disabled; 1: routing double-tap event to INT2 enabled)
INT2_6D	Routing 6D event to INT2. Default value: 0 (0: routing 6D event to INT2 disabled; 1: routing 6D event to INT2 enabled)
INT2_EMB_FUNC	Routing embedded functions event to INT2. Default value: 0 (0: routing embedded functions event to INT2 disabled; 1: routing embedded functions event to INT2 enabled)
INT2_TIMESTAMP	Enables routing the alert for timestamp overflow within 5.6 ms to the INT2 pin.

1. *Activity/inactivity interrupt mode (sleep change or sleep status) depends on the SLEEP_STATUS_ON_INT bit in the INACTIVITY_DUR (54h) register.*

9.67 HAODR_CFG (62h)

HAODR data rate configuration register (R/W)

Table 179. HAODR_CFG register

0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	HAODR_SEL_1	HAODR_SEL _0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 180. HAODR_CFG register description

HAODR_SEL_[1:0]	Selects the ODR set supported when high-accuracy ODR (HAODR) mode is enabled (see Table 20). Default: 00

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9.68 EMB_FUNC_CFG (63h)

Embedded functions configuration register (R/W)

Table 181. EMB_FUNC_CFG register

XL_DualC_BATCH_FROM_IF	0(1)	EMB_FUNC_IRQ_MASK_G_SETTL	EMB_FUNC_IRQ_MASK_XL_SETTL	EMB_FUNC_DISABLE	0(1)	0(1)	0(1)

1. *This bit must be set to 0 for the correct operation of the device.*

Table 182. EMB_FUNC_CFG register description

XL_DualC_BATCH_FROM_IF	When dual-channel mode is enabled, this bit enables batching the accelerometer channel 2 in FIFO. Default value: 0 (0: disabled; 1: enabled)
EMB_FUNC_IRQ_MASK_G_SETTL	Enables / masks execution trigger of the embedded functions when gyroscope data are settling. Default value: 0 (0: disabled; 1: masks execution trigger of the embedded functions until gyroscope filter settling ends) *Note: Refer to the product application note for the details regarding operating/power mode configurations, settings, turn-on/off time and on-the-fly changes.*
EMB_FUNC_IRQ_MASK_XL_SETTL	Enables / masks execution trigger of the embedded functions when accelerometer data are settling. Default value: 0 (0: disabled; 1: masks execution trigger of the embedded functions until accelerometer filter settling ends) *Note: Refer to the product application note for the details regarding operating/power mode configurations, settings, turn-on/off time and on-the-fly changes.*
EMB_FUNC_DISABLE	Disables execution of the embedded functions. Default value: 0 (0: disabled; 1: embedded functions execution trigger is not generated anymore and all initialization procedures are forced when this bit is set back to 0).

9.69 UI_HANDSHAKE_CTRL (64h)

Control register (UI side) for UI / SPI2 shared registers (R/W)

Table 183. UI_HANDSHAKE_CTRL register

0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	UI_SHARED_ACK	UI_SHARED_REQ

1. *This bit must be set to 0 for the correct operation of the device.*

Table 184. UI_HANDSHAKE_CTRL register description

UI_SHARED_ACK	Primary interface side. This bit acknowledges the handshake. If the secondary interface is not accessing the shared registers, this bit is set to 1 by the device and the R/W operation on the UI_SPI2_SHARED_0 (65h) through UI_SPI2_SHARED_5 (6Ah) registers is allowed on the primary interface.
UI_SHARED_REQ	This bit is used by the primary interface master to request access to the UI_SPI2_SHARED_0 (65h) through UI_SPI2_SHARED_5 (6Ah) registers. When the R/W operation is finished, the master must reset this bit.

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9.70 UI_SPI2_SHARED_0 (65h)

UI / SPI2 shared register 0 (R/W)

Table 185. UI_SPI2_SHARED_0 register

D7	D6	D5	D4	D3	D2	D1	D0

Table 186. UI_SPI2_SHARED_0 register description

D[7:0]	Volatile byte is used as a contact point between the primary and secondary interface host. These shared registers are accessible only by one interface at a time and access is managed through the UI_SHARED_ACK and UI_SHARED_REQ bits of register UI_HANDSHAKE_CTRL (64h) and the SPI2_SHARED_ACK and SPI2_SHARED_REQ bits of register SPI2_HANDSHAKE_CTRL (6Eh).

9.71 UI_SPI2_SHARED_1 (66h)

UI / SPI2 shared register 1 (R/W)

Table 187. UI_SPI2_SHARED_1 register

D7	D6	D5	D4	D3	D2	D1	D0

Table 188. UI_SPI2_SHARED_1 register description

D[7:0]	Volatile byte is used as a contact point between the primary and secondary interface host. These shared registers are accessible only by one interface at a time and access is managed through the UI_SHARED_ACK and UI_SHARED_REQ bits of register UI_HANDSHAKE_CTRL (64h) and the SPI2_SHARED_ACK and SPI2_SHARED_REQ bits of register SPI2_HANDSHAKE_CTRL (6Eh).

9.72 UI_SPI2_SHARED_2 (67h)

UI / SPI2 shared register 2 (R/W)

Table 189. UI_SPI2_SHARED_2 register

D7	D6	D5	D4	D3	D2	D1	D0

Table 190. UI_SPI2_SHARED_2 register description

D[7:0]	Volatile byte is used as a contact point between the primary and secondary interface host. These shared registers are accessible only by one interface at a time and access is managed through the UI_SHARED_ACK and UI_SHARED_REQ bits of register UI_HANDSHAKE_CTRL (64h) and the SPI2_SHARED_ACK and SPI2_SHARED_REQ bits of register SPI2_HANDSHAKE_CTRL (6Eh).

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9.73 UI_SPI2_SHARED_3 (68h)

UI / SPI2 shared register 3 (R/W)

Table 191. UI_SPI2_SHARED_3 register

D7	D6	D5	D4	D3	D2	D1	D0

Table 192. UI_SPI2_SHARED_3 register description

D[7:0]	Volatile byte is used as a contact point between the primary and secondary interface host. These shared registers are accessible only by one interface at a time and access is managed through the UI_SHARED_ACK and UI_SHARED_REQ bits of register UI_HANDSHAKE_CTRL (64h) and the SPI2_SHARED_ACK and SPI2_SHARED_REQ bits of register SPI2_HANDSHAKE_CTRL (6Eh).

9.74 UI_SPI2_SHARED_4 (69h)

UI / SPI2 shared register 4 (R/W)

Table 193. UI_SPI2_SHARED_4 register

D7	D6	D5	D4	D3	D2	D1	D0

Table 194. UI_SPI2_SHARED_4 register description

D[7:0]	Volatile byte is used as a contact point between the primary and secondary interface host. These shared registers are accessible only by one interface at a time and access is managed through the UI_SHARED_ACK and UI_SHARED_REQ bits of register UI_HANDSHAKE_CTRL (64h) and the SPI2_SHARED_ACK and SPI2_SHARED_REQ bits of register SPI2_HANDSHAKE_CTRL (6Eh).

9.75 UI_SPI2_SHARED_5 (6Ah)

UI / SPI2 shared register 5 (R/W)

Table 195. UI_SPI2_SHARED_5 register

D7	D6	D5	D4	D3	D2	D1	D0

Table 196. UI_SPI2_SHARED_5 register description

D[7:0]	Volatile byte is used as a contact point between the primary and secondary interface host. These shared registers are accessible only by one interface at a time and access is managed through the UI_SHARED_ACK and UI_SHARED_REQ bits of register UI_HANDSHAKE_CTRL (64h) and the SPI2_SHARED_ACK and SPI2_SHARED_REQ bits of register SPI2_HANDSHAKE_CTRL (6Eh).

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9.76 CTRL_EIS (6Bh)

Gyroscope EIS channel control register (R/W)

Table 197. CTRL_EIS register

ODR_G_EIS_1	ODR_G_EIS_0	0(1)	LPF_G_EIS_BW	G_EIS_ON_G_OIS_OUT_REG	FS_G_EIS_2	FS_G_EIS_1	FS_G_EIS_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 198. CTRL_EIS register description

ODR_G_EIS_[1:0]	Enables and selects the ODR of the gyroscope EIS channel. (00: EIS channel is off (default); 01: 1.92 kHz; 10: 960 Hz; 11: reserved)
LPF_G_EIS_BW	Gyroscope digital LPF_EIS filter bandwidth selection. Refer to Table 199.
G_EIS_ON_G_OIS_OUT_REG	Enables routing gyroscope EIS output to OIS from UI output addresses (2Eh – 33h). When this bit is set to 1, the gyroscope OIS data cannot be read from primary interface. Default value: 0 (0: disabled; 1: enabled)
FS_G_EIS_[2:0]	Gyroscope full-scale selection for EIS channel. If the FS_G_[3:0] bits in CTRL6 (15h) are equal to 1100 (±4000 dps), FS_G_EIS_[2:0] must be set to “100” in order to have ±4000 dps full scale on both UI and EIS channels. If the FS_G_3 bit in register CTRL6 (15h) is equal to 0, the EIS channel full scale can be selected as follows: (000: ±125 dps (default); 001: ±250 dps; 010: ±500 dps; 011: ±1000 dps; 100: ±2000 dps; 101: reserved; 110: reserved; 111: reserved)

Table 199. Gyroscope EIS chain digital LPF_EIS filter bandwidth selection

ODR_G_EIS_[1:0]	Gyroscope EIS ODR [Hz]	LPF_G_EIS_BW	Cutoff [Hz]	Phase @ 20 Hz [°]
01	1.92 kHz	0	153 Hz	-13.5°
		1	203 Hz	-10.8°
10	960	0	148 Hz	-15.4°
		1	193 Hz	-12.7°

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9.77 UI_INT_OIS (6Fh)

OIS interrupt configuration register

The primary interface can write to this register when the OIS_CTRL_FROM_UI bit in the FUNC_CFG_ACCESS (01h) register is equal to 1 (primary IF full-control mode); this register is read-only when the OIS_CTRL_FROM_UI bit is equal to 0 (SPI2 full-control mode) and shows the content of the SPI2_INT_OIS (6Fh) register.

Table 200. UI_INT_OIS register

INT2_ DRDY_OIS	DRDY_ MASK_OIS	0(1)	ST_OIS_ CLAMPDIS	0(1)	0(1)	0(1)	0(1)

1. *This bit must be set to 0 for the correct operation of the device.*

Table 201. UI_INT_OIS register description

INT2_DRDY_OIS	Enables OIS chain DRDY on INT2 pin from the UI interface. This setting has priority over all other INT2 settings.
DRDY_MASK_OIS	Enables / masks OIS data available. Default value: 0 (0: disabled; 1: masks OIS DRDY signals (both accelerometer and gyroscope) until filter settling ends (accelerometer and gyroscope independently masked))
ST_OIS_CLAMPDIS	Disables OIS chain clamp during self-test. Default value: 0 (0: All OIS chain outputs = 8000h during self-test; 1: OIS chain self-test outputs)

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9.78 UI_CTRL1_OIS (70h)

OIS configuration register

The primary interface can write this register when the OIS_CTRL_FROM_UI bit in the FUNC_CFG_ACCESS (01h) register is equal to 1 (primary IF full-control mode); this register is read-only when the OIS_CTRL_FROM_UI bit is equal to 0 (SPI2 full-control mode) and shows the content of the SPI2_CTRL1_OIS (70h) register.

Table 202. UI_CTRL1_OIS register

0(1)	0(1)	SIM_OIS	0(1)	0(1)	OIS_ XL_EN	OIS_ G_EN	SPI2_READ _EN

1. *This bit must be set to 0 for the correct operation of the device.*

Table 203. UI_CTRL1_OIS register description

SIM_OIS	SPI2 3- or 4-wire interface. Default value: 0 (0: 4-wire SPI2; 1: 3-wire SPI2)
OIS_XL_EN	Enables accelerometer OIS chain. Default value: 0 (0: accelerometer OIS chain disabled; 1: accelerometer OIS chain enabled)
OIS_G_EN	Enables gyroscope OIS chain. Default value: 0 (0: gyroscope OIS chain disabled; 1: gyroscope OIS chain enabled)
SPI2_READ_EN	In primary IF full-control mode, enables auxiliary SPI for reading OIS data in registers SPI2_OUTX_L_G_OIS (22h) and SPI2_OUTX_H_G_OIS (23h) through Section 11.9 SPI2_OUTZ_L_A_OIS (2Ch) and SPI2_OUTZ_H_A_OIS (2Dh). Default value: 0 (0: OIS data read from auxiliary SPI disabled; 1: OIS data read from auxiliary SPI enabled)

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9.79 UI_CTRL2_OIS (71h)

OIS configuration register

The primary interface can write this register when the OIS_CTRL_FROM_UI bit in the FUNC_CFG_ACCESS (01h) register is equal to 1 (primary IF full-control mode); this register is read-only when the OIS_CTRL_FROM_UI bit is equal to 0 (SPI2 full-control mode) and shows the content of the SPI2_CTRL2_OIS (71h) register.

Table 204. UI_CTRL2_OIS register

0(1)	0(1)	0(1)	LPF1_G_ OIS_BW_1	LPF1_G_ OIS_BW_0	FS_G _OIS_2	FS_G _OIS_1	FS_G _OIS_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 205. UI_CTRL2_OIS register description

LPF1_G_OIS_BW_[1:0]	Gyroscope OIS digital LPF1 filter bandwidth selection. Refer to Table 206.
FS_G_OIS_[2:0]	Gyroscope OIS full-scale selection: (000: ±125 dps; 001: ±250 dps; 010: ±500 dps; 011: ±1000 dps; 100: ±2000 dps; 101: reserved; 110: reserved; 111: reserved)

Table 206. Gyroscope OIS chain digital LPF1 filter bandwidth selection

LPF1_G_OIS_BW_[1:0]	Cutoff [Hz]	Phase @ 20 Hz [°]
00	293 Hz	-7.1°
01	217 Hz	-9.1°
10	158 Hz	-11.9°
11	476 Hz	-5.1°

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9.80 UI_CTRL3_OIS (72h)

OIS configuration register

The primary interface can write this register when the OIS_CTRL_FROM_UI bit in the FUNC_CFG_ACCESS (01h) register is equal to 1 (primary IF full-control mode); this register is read-only when the OIS_CTRL_FROM_UI bit is equal to 0 (SPI2 full-control mode) and shows the content of the SPI2_CTRL3_OIS (72h) register.

Table 207. UI_CTRL3_OIS register

0(1)	0(1)	LPF_XL_ OIS_BW_2	LPF_XL_ OIS_BW_1	LPF_XL_ OIS_BW_0	0(1)	FS_XL _OIS_1	FS_XL _OIS_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 208. UI_CTRL3_OIS register description

LPF_XL_OIS_BW_[2:0]	Selects accelerometer OIS channel bandwidth, see Table 209. Default value: 0
FS_XL_OIS_[1:0]	Selects accelerometer OIS channel full-scale: (00: ±2 *g* (default); 01: ±4 *g*; 10: ±8 *g*; 11: ±16 *g*)

Note: When the accelerometer full-scale value is selected only from the UI side it is readable also from the OIS side.

Table 209. Accelerometer OIS channel bandwidth and phase

LPF_XL_OIS_BW_[2:0]	Typ. overall bandwidth [Hz]	Typ. overall phase [°]
000	749 Hz	-3.41 deg @ 20 Hz
001	539 Hz	-4.04 deg@ 20 Hz
010	342 Hz	-5.31 deg@ 20 Hz
011	162 Hz	-9.08 deg@ 20 Hz
100	78.5 Hz	-16.4 deg @ 20 Hz
101	38.6 Hz	-29.6 deg@ 20 Hz
110	19.3 Hz	-28.8 deg @ 10 Hz
111	9.8 Hz	-29.1 deg @ 5 Hz

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9.81 X_OFS_USR (73h)

Accelerometer X-axis user offset correction (R/W). The offset value set in the X_OFS_USR offset register is internally subtracted from the acceleration value measured on the X-axis.

Table 210. X_OFS_USR register

X_OFS_USR_7	X_OFS_USR_6	X_OFS_USR_5	X_OFS_USR_4	X_OFS_USR_3	X_OFS_USR_2	X_OFS_USR_1	X_OFS_USR_0

Table 211. X_OFS_USR register description

X_OFS_USR_[7:0]	Accelerometer X-axis user offset correction expressed in two's complement, weight depends on USR_OFF_W in CTRL9 (18h). The offset can be applied to the output registers (see USR_OFF_ON_OUT bit in the CTRL9 (18h) register) or to the wake-up function input data (see USR_OFF_ON_WU bit in the WAKE_UP_THS (5Bh) register). The value must be in the range [-127 127].

9.82 Y_OFS_USR (74h)

Accelerometer Y-axis user offset correction (R/W). The offset value set in the Y_OFS_USR offset register is internally subtracted from the acceleration value measured on the Y-axis.

Table 212. Y_OFS_USR register

Y_OFS_USR_7	Y_OFS_USR_6	Y_OFS_USR_5	Y_OFS_USR_4	Y_OFS_USR_3	Y_OFS_USR_2	Y_OFS_USR_1	Y_OFS_USR_0

Table 213. Y_OFS_USR register description

Y_OFS_USR_[7:0]	Accelerometer Y-axis user offset correction expressed in two's complement, weight depends on USR_OFF_W in CTRL9 (18h). The offset can be applied to the output registers (see USR_OFF_ON_OUT bit in the CTRL9 (18h) register) or to the wake-up function input data (see USR_OFF_ON_WU bit in the WAKE_UP_THS (5Bh) register). The value must be in the range [-127 127].

9.83 Z_OFS_USR (75h)

Accelerometer Z-axis user offset correction (R/W). The offset value set in the Z_OFS_USR offset register is internally subtracted from the acceleration value measured on the Z-axis.

Table 214. Z_OFS_USR register

Z_OFS_USR_7	Z_OFS_USR_6	Z_OFS_USR_5	Z_OFS_USR_4	Z_OFS_USR_3	Z_OFS_USR_2	Z_OFS_USR_1	Z_OFS_USR_0

Table 215. Z_OFS_USR register description

Z_OFS_USR_[7:0]	Accelerometer Z-axis user offset correction expressed in two's complement, weight depends on USR_OFF_W in CTRL9 (18h). The offset can be applied to the output registers (see USR_OFF_ON_OUT bit in the CTRL9 (18h) register) or to the wake-up function input data (see USR_OFF_ON_WU bit in the WAKE_UP_THS (5Bh) register). The value must be in the range [-127 127].

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9.84 FIFO_DATA_OUT_TAG (78h)

FIFO tag register (R)

Table 216. FIFO_DATA_OUT_TAG register

TAG_ SENSOR_4	TAG_ SENSOR_3	TAG_ SENSOR_2	TAG_ SENSOR_1	TAG_ SENSOR_0	TAG_CNT_1	TAG_CNT_0	-

Table 217. FIFO_DATA_OUT_TAG register description

TAG_SENSOR_[4:0]	FIFO tag. Identifies the sensor in: FIFO_DATA_OUT_X_L (79h) and FIFO_DATA_OUT_X_H (7Ah), FIFO_DATA_OUT_Y_L (7Bh) and FIFO_DATA_OUT_Y_H (7Ch), and FIFO_DATA_OUT_Z_L (7Dh) and FIFO_DATA_OUT_Z_H (7Eh) For details, refer to Table 218.
TAG_CNT_[1:0]	2-bit counter which identifies sensor time slot

Table 218. FIFO tag

TAG_SENSOR_[4:0]	Sensor name
0x00	FIFO empty
0x01	Gyroscope NC
0x02	Accelerometer NC
0x03	Temperature
0x04	Timestamp
0x05	CFG_Change
0x06	Accelerometer NC_T_2
0x07	Accelerometer NC_T_1
0x08	Accelerometer 2xC
0x09	Accelerometer 3xC
0x0A	Gyroscope NC_T_2
0x0B	Gyroscope NC_T_1
0x0C	Gyroscope 2xC
0x0D	Gyroscope 3xC
0x0E	Sensor hub slave 0
0x0F	Sensor hub slave 1
0x10	Sensor hub slave 2
0x11	Sensor hub slave 3
0x12	Step counter
0x13	SFLP game rotation vector
0x16	SFLP gyroscope bias
0x17	SFLP gravity vector
0x19	Sensor hub nack
0x1A	MLC result
0x1B	MLC filter
0x1C	MLC feature
0x1D	Accelerometer dualC
0x1E	Enhanced EIS gyroscope

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9.85 FIFO_DATA_OUT_X_L (79h) and FIFO_DATA_OUT_X_H (7Ah)

FIFO data output X (R)

Table 219. FIFO_DATA_OUT_X_H and FIFO_DATA_OUT_X_L registers

D15	D14	D13	D12	D11	D10	D9	D8
D7	D6	D5	D4	D3	D2	D1	D0

Table 220. FIFO_DATA_OUT_X_H and FIFO_DATA_OUT_X_L register description

D[15:0]	FIFO X-axis output

9.86 FIFO_DATA_OUT_Y_L (7Bh) and FIFO_DATA_OUT_Y_H (7Ch)

FIFO data output Y (R)

Table 221. FIFO_DATA_OUT_Y_H and FIFO_DATA_OUT_Y_L registers

D15	D14	D13	D12	D11	D10	D9	D8
D7	D6	D5	D4	D3	D2	D1	D0

Table 222. FIFO_DATA_OUT_Y_H and FIFO_DATA_OUT_Y_L register description

D[15:0]	FIFO Y-axis output

9.87 FIFO_DATA_OUT_Z_L (7Dh) and FIFO_DATA_OUT_Z_H (7Eh)

FIFO data output Z (R)

Table 223. FIFO_DATA_OUT_Z_H and FIFO_DATA_OUT_Z_L registers

D15	D14	D13	D12	D11	D10	D9	D8
D7	D6	D5	D4	D3	D2	D1	D0

Table 224. FIFO_DATA_OUT_Z_H and FIFO_DATA_OUT_Z_L register description

D[15:0]	FIFO Z-axis output

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10 SPI2 register mapping

The table given below provides a list of the 8/16-bit registers embedded in the device and the corresponding addresses.

All these registers are accessible from auxiliary SPI interface only.

Table 225. SPI2 register address map

Name	Type	Register address		Default	Comment
		Hex	Binary		
SPI2_WHO_AM_I	R	0F	00001111	01110000	
SPI2_STATUS_REG_OIS	R	1E	00011110	output	
SPI2_OUT_TEMP_L	R	20	00100000	output	
SPI2_OUT_TEMP_H	R	21	00100001	output	
SPI2_OUTX_L_G_OIS	R	22	00100010	output	
SPI2_OUTX_H_G_OIS	R	23	00100011	output	
SPI2_OUTY_L_G_OIS	R	24	00100100	output	
SPI2_OUTY_H_G_OIS	R	25	00100101	output	
SPI2_OUTZ_L_G_OIS	R	26	00100110	output	
SPI2_OUTZ_H_G_OIS	R	27	00100111	output	
SPI2_OUTX_L_A_OIS	R	28	00101000	output	
SPI2_OUTX_H_A_OIS	R	29	00101001	output	
SPI2_OUTY_L_A_OIS	R	2A	00101010	output	
SPI2_OUTY_H_A_OIS	R	2B	00101011	output	
SPI2_OUTZ_L_A_OIS	R	2C	00101100	output	
SPI2_OUTZ_H_A_OIS	R	2D	00101101	output	
SPI2_HANDSHAKE_CTRL	R/W	6E	01101110	00000000	
SPI2_INT_OIS	R/W (SPI2 full-control mode) R (primary IF full-control mode)	6F	01101111	00000000	
SPI2_CTRL1_OIS	R/W (SPI2 full-control mode) R (primary IF full-control mode)	70	01110000	00000000	
SPI2_CTRL2_OIS	R/W (SPI2 full-control mode) R (primary IF full-control mode)	71	01110001	00000000	
SPI2_CTRL3_OIS	R/W (SPI2 full-control mode) R (primary IF full-control mode)	72	01110010	00000000	

Reserved registers must not be changed. Writing to those registers may cause permanent damage to the device.

The content of the registers that are loaded at boot should not be changed. They contain the factory calibration values. Their content is automatically restored when the device is powered up.

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11 SPI2 register description

11.1 SPI2_WHO_AM_I (0Fh)

WHO_AM_I register (R). This is a read-only register. Its value is fixed at 70h.

Table 226. SPI2_WhoAmI register

0	1	1	1	0	0	0	0

11.2 SPI2_STATUS_REG_OIS (1Eh)

The SPI2_STATUS_REG_OIS register is read by the auxiliary SPI (R).

Table 227. SPI2_STATUS_REG_OIS register

0	0	0	0	0	GYRO_ SETTLING	GDA	XLDA

Table 228. SPI2_STATUS_REG_OIS description

GYRO_SETTLING	High when the gyroscope output is in the settling phase
GDA	Gyroscope data available (reset when one of the high parts of the output data is read)
XLDA	Accelerometer data available (reset when one of the high parts of the output data is read)

11.3 SPI2_OUT_TEMP_L (20h) and SPI2_OUT_TEMP_H (21h)

Temperature data output register (R). L and H registers together express a 16-bit word in two’s complement.

Table 229. SPI2_OUT_TEMP_L register

Temp7	Temp6	Temp5	Temp4	Temp3	Temp2	Temp1	Temp0

Table 230. SPI2_OUT_TEMP_H register

Temp15	Temp14	Temp13	Temp12	Temp11	Temp10	Temp9	Temp8

Table 231. SPI2_OUT_TEMP register description

Temp[15:0]	Temperature sensor output data The value is expressed as two’s complement sign extended on the MSB.

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11.4 SPI2_OUTX_L_G_OIS (22h) and SPI2_OUTX_H_G_OIS (23h)

Angular rate sensor pitch axis (X) angular rate output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the gyroscope full-scale and ODR (7.68 kHz) settings of the OIS gyroscope.

Table 232. SPI2_OUTX_L_G_OIS register

D7	D6	D5	D4	D3	D2	D1	D0

Table 233. SPI2_OUTX_H_G_OIS register

D15	D14	D13	D12	D11	D10	D9	D8

Table 234. SPI2_OUTX_H_G_OIS register description

D[15:0]	Gyroscope OIS chain pitch axis (X) angular rate output value

11.5 SPI2_OUTY_L_G_OIS (24h) and SPI2_OUTY_H_G_OIS (25h)

Angular rate sensor roll axis (Y) angular rate output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the gyroscope full-scale and ODR (7.68 kHz) settings of the OIS gyroscope.

Table 235. SPI2_OUTY_L_G_OIS register

D7	D6	D5	D4	D3	D2	D1	D0

Table 236. SPI2_OUTY_H_G_OIS register

D15	D14	D13	D12	D11	D10	D9	D8

Table 237. SPI2_OUTY_H_G_OIS register description

D[15:0]	Gyroscope OIS chain roll axis (Y) angular rate output value

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11.6 SPI2_OUTZ_L_G_OIS (26h) and SPI2_OUTZ_H_G_OIS (27h)

Angular rate sensor yaw axis (Z) angular rate output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the gyroscope full-scale and ODR (7.68 kHz) settings of the OIS gyroscope.

Table 238. SPI2_OUTZ_L_G_OIS register

D7	D6	D5	D4	D3	D2	D1	D0

Table 239. SPI2_OUTZ_H_G_OIS register

D15	D14	D13	D12	D11	D10	D9	D8

Table 240. SPI2_OUTZ_H_G_OIS register description

D[15:0]	Gyroscope OIS chain yaw axis (Z) angular rate output value

11.7 SPI2_OUTX_L_A_OIS (28h) and SPI2_OUTX_H_A_OIS (29h)

Linear acceleration sensor X-axis output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the accelerometer full scale and ODR (7.68 kHz) settings of the OIS accelerometer.

Table 241. SPI2_OUTX_L_A_OIS register

D7	D6	D5	D4	D3	D2	D1	D0

Table 242. SPI2_OUTX_H_A_OIS register

D15	D14	D13	D12	D11	D10	D9	D8

Table 243. SPI2_OUTX_H_A_OIS register description

D[15:0]	Accelerometer OIS chain X-axis linear acceleration output value

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11.8 SPI2_OUTY_L_A_OIS (2Ah) and SPI2_OUTY_H_A_OIS (2Bh)

Linear acceleration sensor Y-axis output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the accelerometer full scale and ODR (7.68 kHz) settings of the OIS accelerometer.

Table 244. SPI2_OUTY_L_A_OIS register

D7	D6	D5	D4	D3	D2	D1	D0

Table 245. SPI2_OUTY_H_A_OIS register

D15	D14	D13	D12	D11	D10	D9	D8

Table 246. SPI2_OUTY_H_A_OIS register description

D[15:0]	Accelerometer OIS chain Y-axis linear acceleration output value

11.9 SPI2_OUTZ_L_A_OIS (2Ch) and SPI2_OUTZ_H_A_OIS (2Dh)

Linear acceleration sensor Z-axis output register (R). The value is expressed as a 16-bit word in two's complement.

Data are according to the accelerometer full scale and ODR (7.68 kHz) settings of the OIS accelerometer.

Table 247. SPI2_OUTZ_L_A_OIS register

D7	D6	D5	D4	D3	D2	D1	D0

Table 248. SPI2_OUTZ_H_A_OIS register

D15	D14	D13	D12	D11	D10	D9	D8

Table 249. SPI2_OUTZ_H_A_OIS register description

D[15:0]	Accelerometer OIS chain Z-axis linear acceleration output value

11.10 SPI2_HANDSHAKE_CTRL (6Eh)

Control register (SPI2 side) for UI / SPI2 shared registers (R/W)

Table 250. SPI2_HANDSHAKE_CTRL register

0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	SPI2_ SHARED_REQ	SPI2_ SHARED_ACK

1. *This bit must be set to 0 for the correct operation of the device.*

Table 251. SPI2_HANDSHAKE_CTRL register description

SPI2_SHARED_REQ	This bit is used by the auxiliary SPI (SPI2) interface master to request access to the UI_SPI2_SHARED_0 (65h) through UI_SPI2_SHARED_5 (6Ah) registers. When the R/W operation is finished, the master must reset this bit.
SPI2_SHARED_ACK	Auxiliary SPI (SPI2) interface side. This bit acknowledges the handshake. If the primary interface is not accessing the shared registers, this bit is set to 1 by the device and the R/W operation on the UI_SPI2_SHARED_0 (65h) through UI_SPI2_SHARED_5 (6Ah) registers is allowed on the auxiliary SPI interface.

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11.11 SPI2_INT_OIS (6Fh)

OIS interrupt configuration register and self-test setting

The auxiliary SPI interface can write this register when the OIS_CTRL_FROM_UI bit in the FUNC_CFG_ACCESS (01h) register is equal to 0 (SPI2 full-control mode); this register is read-only when the OIS_CTRL_FROM_UI bit is equal to 1 (primary IF full-control mode) and shows the content of the UI_INT_OIS (6Fh) register.

Table 252. SPI2_INT_OIS register

INT2_ DRDY_OIS	DRDY_MASK _OIS	0(1)	ST_OIS_ CLAMPDIS	ST_G_ OIS_1	ST_G_ OIS_0	ST_XL_ OIS_1	ST_XL_ OIS_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 253. SPI2_INT_OIS register description

INT2_DRDY_OIS	Enables OIS chain DRDY on INT2 pin. This setting has priority over all other INT2 settings.
DRDY_MASK_OIS	Enables / masks OIS data available. Default value: 0 (0: disabled; 1: masks OIS DRDY on pin (both accelerometer and gyroscope) until filter settling ends (accelerometer and gyroscope independently masked))
ST_OIS_CLAMPDIS	Disables OIS chain clamp during self-test. Default value: 0 (0: All OIS chain outputs = 8000h during self-test; 1: OIS chain self-test outputs)
ST_G_OIS_[1:0]	Gyroscope OIS chain self-test selection when the self-test is enabled and ST_OIS_CLAMPDIS = 0. (00: normal mode (default); 01: positive sign self-test; 10: normal mode; 11: negative sign self-test)
ST_XL_OIS_[1:0]	Accelerometer OIS chain self-test selection; activated only if the accelerometer OIS chain is enabled. (00: normal mode (default); 01: positive sign self-test; 10: negative sign self-test; 11: reserved)

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11.12 SPI2_CTRL1_OIS (70h)

OIS configuration register

The auxiliary SPI interface can write this register when the OIS_CTRL_FROM_UI bit in the FUNC_CFG_ACCESS (01h) register is equal to 0 (SPI2 full-control mode); this register is read-only when the OIS_CTRL_FROM_UI bit is equal to 1 (primary IF full-control mode) and shows the content of the UI_CTRL1_OIS (70h) register.

Table 254. SPI2_CTRL1_OIS register

0(1)	0(1)	SIM_OIS	0(1)	0(1)	OIS_ XL_EN	OIS_ G_EN	SPI2_READ _EN

1. *This bit must be set to 0 for the correct operation of the device.*

Table 255. SPI2_CTRL1_OIS register description

SIM_OIS	SPI2 3- or 4-wire interface. Default value: 0 (0: 4-wire SPI2; 1: 3-wire SPI2)
OIS_XL_EN	Enables accelerometer OIS chain. Default value: 0 (0: accelerometer OIS chain disabled; 1: accelerometer OIS chain enabled)
OIS_G_EN	Enables gyroscope OIS chain. Default value: 0 (0: gyroscope OIS chain disabled; 1: gyroscope OIS chain enabled)
SPI2_READ_EN	In auxiliary SPI full-control mode, enables auxiliary SPI for reading OIS data in registers SPI2_OUTX_L_G_OIS (22h) and SPI2_OUTX_H_G_OIS (23h) through Section 11.9 SPI2_OUTZ_L_A_OIS (2Ch) and SPI2_OUTZ_H_A_OIS (2Dh). Default value: 0 (0: OIS data read from auxiliary SPI disabled; 1: OIS data read from auxiliary SPI enabled)

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11.13 SPI2_CTRL2_OIS (71h)

OIS configuration register

The auxiliary SPI interface can write this register when the OIS_CTRL_FROM_UI bit in the FUNC_CFG_ACCESS (01h) register is equal to 0 (SPI2 full-control mode); this register is read-only when the OIS_CTRL_FROM_UI bit is equal to 1 (primary IF full-control mode) and shows the content of the UI_CTRL2_OIS (71h) register.

Table 256. SPI2_CTRL2_OIS register

0(1)	0(1)	0(1)	LPF1_G_ OIS_BW_1	LPF1_G_ OIS_BW_0	FS_G _OIS_2	FS_G _OIS_1	FS_G _OIS_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 257. SPI2_CTRL2_OIS register description

LPF1_G_OIS_BW_[1:0]	Gyroscope OIS digital LPF1 filter bandwidth selection. Refer to Table 258.
FS_G_OIS_[2:0]	Gyroscope OIS full-scale selection: (000: ±125 dps; 001: ±250 dps; 010: ±500 dps; 011: ±1000 dps; 100: ±2000 dps; 101: reserved; 110: reserved; 111: reserved)

Table 258. Gyroscope OIS chain digital LPF1 filter bandwidth selection

LPF1_G_OIS_BW_[1:0]	Cutoff [Hz]	Phase @ 20 Hz [°]
00	293 Hz	-7.1°
01	217 Hz	-9.1°
10	158 Hz	-11.9°
11	476 Hz	-5.1°

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11.14 SPI2_CTRL3_OIS (72h)

OIS configuration register

The auxiliary SPI interface can write this register when the OIS_CTRL_FROM_UI bit in the FUNC_CFG_ACCESS (01h) register is equal to 0 (SPI2 full-control mode); this register is read-only when the OIS_CTRL_FROM_UI bit is equal to 1 (primary IF full-control mode) and shows the content of the UI_CTRL3_OIS (72h) register.

Table 259. SPI2_CTRL3_OIS register

0(1)	0(1)	LPF_XL_ OIS_BW_2	LPF_XL_ OIS_BW_1	LPF_XL_ OIS_BW_0	0(1)	FS_XL _OIS_1	FS_XL _OIS_0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 260. SPI2_CTRL3_OIS register description

LPF_XL_OIS_BW_[2:0]	Selects accelerometer OIS channel bandwidth, see Table 261. Default value: 0
FS_XL_OIS_[1:0]	Selects accelerometer OIS channel full-scale: (00: ±2 *g* (default); 01: ±4 *g*; 10: ±8 *g*; 11: ±16 *g*)

Note: When the accelerometer full-scale value is selected only from the UI side it is readable also from the OIS side.

Table 261. Accelerometer OIS channel bandwidth and phase

LPF_XL_OIS_BW_[2:0]	Typ. overall bandwidth [Hz]	Typ. overall phase [°]
000	749 Hz	-3.41 deg @ 20 Hz
001	539 Hz	-4.04 deg@ 20 Hz
010	342 Hz	-5.31 deg@ 20 Hz
011	162 Hz	-9.08 deg@ 20 Hz
100	78.5 Hz	-16.4 deg @ 20 Hz
101	38.6 Hz	-29.6 deg@ 20 Hz
110	19.3 Hz	-28.8 deg @ 10 Hz
111	9.8 Hz	-29.1 deg @ 5 Hz

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12 Embedded functions register mapping

The table given below provides a list of the registers for the embedded functions available in the device and the corresponding addresses. Embedded functions registers are accessible when EMB_FUNC_REG_ACCESS is set to 1 in FUNC_CFG_ACCESS (01h).

Table 262. Register address map - embedded functions

Name	Type	Register address		Default	Comment
		Hex	Binary		
PAGE_SEL	R/W	02	00000010	00000001	
EMB_FUNC_EN_A	R/W	04	00000100	00000000	
EMB_FUNC_EN_B	R/W	05	00000101	00000000	
EMB_FUNC_EXEC_STATUS	R	07	00000111	output	
PAGE_ADDRESS	R/W	08	00001000	00000000	
PAGE_VALUE	R/W	09	00001001	00000000	
EMB_FUNC_INT1	R/W	0A	00001010	00000000	
FSM_INT1	R/W	0B	00001011	00000000	
RESERVED	-	0C			
MLC_INT1	R/W	0D	00001101	00000000	
EMB_FUNC_INT2	R/W	0E	00001110	00000000	
FSM_INT2	R/W	0F	00001111	00000000	
RESERVED	-	10			
MLC_INT2	R/W	11	00010001	00000000	
EMB_FUNC_STATUS	R	12	00010010	output	
FSM_STATUS	R	13	00010011	output	
RESERVED	-	14			
MLC_STATUS	R	15	00010101	output	
PAGE_RW	R/W	17	00010111	00000000	
RESERVED	-	18-43			
EMB_FUNC_FIFO_EN_A	R/W	44	01000100	00000000	
EMB_FUNC_FIFO_EN_B	R/W	45	01000101		
FSM_ENABLE	R/W	46	01000110	00000000	
RESERVED	-	47			
FSM_LONG_COUNTER_L	R/W	48	01001000	00000000	
FSM_LONG_COUNTER_H	R/W	49	01001001	00000000	
RESERVED	-	4A			
INT_ACK_MASK	R/W	4B	01001011	00000000	
FSM_OUTS1	R	4C	01001100	output	
FSM_OUTS2	R	4D	01001101	output	
FSM_OUTS3	R	4E	01001110	output	
FSM_OUTS4	R	4F	01001111	output	
FSM_OUTS5	R	50	01010000	output	
FSM_OUTS6	R	51	01010001	output	

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Name	Type	Register address		Default	Comment
		Hex	Binary		
FSM_OUTS7	R	52	01010010	output	
FSM_OUTS8	R	53	01010011	output	
RESERVED	-	54- 5D			
SFLP_ODR	R/W	5E	01011110	01011011	
FSM_ODR	R/W	5F	01011111	01001011	
MLC_ODR	R/W	60	01100000	00010101	
STEP_COUNTER_L	R	62	01100010	output	
STEP_COUNTER_H	R	63	01100011	output	
EMB_FUNC_SRC	R/W	64	01100100	output	
EMB_FUNC_INIT_A	R/W	66	01100110	00000000	
EMB_FUNC_INIT_B	R/W	67	01100111	00000000	
MLC1_SRC	R	70	01110000	output	
MLC2_SRC	R	71	01110001	output	
MLC3_SRC	R	72	01110010	output	
MLC4_SRC	R	73	01110011	output	

Reserved registers must not be changed. Writing to those registers may cause permanent damage to the device.
The content of the registers that are loaded at boot should not be changed. They contain the factory calibration values. Their content is automatically restored when the device is powered up.

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13 Embedded functions register description

13.1 PAGE_SEL (02h)

Enable advanced features dedicated page (R/W)

Table 263. PAGE_SEL register

PAGE_SEL3	PAGE_SEL2	PAGE_SEL1	PAGE_SEL0	0(1)	0(1)	0(1)	1(2)

1. *This bit must be set to 0 for the correct operation of the device.*
2. *This bit must be set to 1 for the correct operation of the device.*

Table 264. PAGE_SEL register description

PAGE_SEL[3:0]	Selects the advanced features dedicated page. Default value: 0000

13.2 EMB_FUNC_EN_A (04h)

Enable embedded functions register (R/W)

Table 265. EMB_FUNC_EN_A register

MLC_BEFORE_FSM_EN	0(1)	SIGN_MOTION_EN	TILT_EN	PEDO_EN	0(1)	SFLP_GAME_EN	0(1)

1. *This bit must be set to 0 for the correct operation of the device.*

Table 266. EMB_FUNC_EN_A register description

MLC_BEFORE_FSM_EN(1)	Enables machine learning core function. When the machine learning core is enabled by setting this bit to 1, the MLC algorithms are executed before the FSM programs. Default value: 0 (0: machine learning core function disabled; 1: machine learning core function enabled and executed before FSM programs)
SIGN_MOTION_EN	Enables significant motion detection function. Default value: 0 (0: significant motion detection function disabled; 1: significant motion detection function enabled)
TILT_EN	Enables tilt calculation. Default value: 0 (0: tilt algorithm disabled; 1: tilt algorithm enabled)
PEDO_EN	Enables pedometer algorithm. Default value: 0 (0: pedometer algorithm disabled; 1: pedometer algorithm enabled)
SFLP_GAME_EN	Enables sensor fusion low-power algorithm for 6-axis (accelerometer + gyroscope) game rotation vector. Default value: 0 (0: sensor fusion algorithm for 6-axis accelerometer + gyroscope disabled; 1: sensor fusion algorithm for 6-axis accelerometer + gyroscope enabled)

1. *MLC_EN bit in the EMB_FUNC_EN_B (05h) register must be set to 0 when using this bit.*

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13.3 EMB_FUNC_EN_B (05h)

Enable embedded functions register (R/W)

Table 267. EMB_FUNC_EN_B register

0(1)	0(1)	0(1)	MLC_EN	FIFO_ COMPR_EN	0(1)	0(1)	FSM_EN

1. *This bit must be set to 0 for the correct operation of the device.*

Table 268. EMB_FUNC_EN_B register description

MLC_EN(1)	Enables machine learning core function. When the machine learning core is enabled by setting this bit to 1, the MLC algorithms are executed after executing the FSM programs. Default value: 0 (0: machine learning core function disabled; 1: machine learning core function enabled and executed after FSM programs)
FIFO_COMPR_EN(2)	Enables FIFO compression function. Default value: 0 (0: FIFO compression function disabled; 1: FIFO compression function enabled)
FSM_EN	Enables finite state machine (FSM) function. Default value: 0 (0: FSM function disabled; 1: FSM function enabled)

1. *MLC_BEFORE_FSM_EN bit in the EMB_FUNC_EN_A (04h) register must be set to 0 when using this bit.*
2. *This bit is activated if the FIFO_COMPR_RT_EN bit of FIFO_CTRL2 (08h) is set to 1.*

13.4 EMB_FUNC_EXEC_STATUS (07h)

Embedded functions execution status register (R)

Table 269. EMB_FUNC_EXEC_STATUS register

0	0	0	0	0	0	EMB_FUNC_ EXEC_OVR	EMB_FUNC _ENDOP

Table 270. EMB_FUNC_EXEC_STATUS register description

EMB_FUNC_EXEC_OVR	This bit is set to 1 when the execution of the embedded functions program exceeds maximum time (new data are generated before the end of the algorithms). Default value: 0
EMB_FUNC_ENDOP	When this bit is set to 1, no embedded function is running. Default value: 0

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13.5 PAGE_ADDRESS (08h)

Page address register (R/W)

Table 271. PAGE_ADDRESS register

PAGE_ ADDR7	PAGE_ ADDR6	PAGE_ ADDR5	PAGE_ ADDR4	PAGE_ ADDR3	PAGE_ ADDR2	PAGE_ ADDR1	PAGE_ ADDR0

Table 272. PAGE_ADDRESS register description

PAGE_ADDR[7:0]	After setting the bit PAGE_WRITE / PAGE_READ in register PAGE_RW (17h), this register is used to set the address of the register to be written/read in the advanced features page selected through the bits PAGE_SEL[3:0] in register PAGE_SEL (02h).

13.6 PAGE_VALUE (09h)

Page value register (R/W)

Table 273. PAGE_VALUE register

PAGE_ VALUE7	PAGE_ VALUE6	PAGE_ VALUE5	PAGE_ VALUE4	PAGE_ VALUE3	PAGE_ VALUE2	PAGE_ VALUE1	PAGE_ VALUE0

Table 274. PAGE_VALUE register description

PAGE_VALUE[7:0]	These bits are used to write (if the bit PAGE_WRITE = 1 in register PAGE_RW (17h)) or read (if the bit PAGE_READ = 1 in register PAGE_RW (17h)) the data at the address PAGE_ADDR[7:0] of the selected advanced features page.

13.7 EMB_FUNC_INT1 (0Ah)

INT1 pin control register (R/W)

Each bit in this register enables a signal to be carried over INT1. The pin's output supplies the OR combination of the selected signals.

Table 275. EMB_FUNC_INT1 register

INT1_ FSM_LC	0(1)	INT1_ SIG_MOT	INT1_TILT	INT1_STEP _DETECTOR	0(1)	0(1)	0(1)

1. *This bit must be set to 0 for the correct operation of the device.*

Table 276. EMB_FUNC_INT1 register description

INT1_FSM_LC(1)	Routing FSM long counter timeout interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_SIG_MOT(1)	Routing significant motion event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_TILT(1)	Routing tilt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_STEP_DETECTOR(1)	Routing pedometer step recognition event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)

1. *This bit is activated if the INT1_EMB_FUNC bit of MD1_CFG (5Eh) is set to 1.*

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13.8 FSM_INT1 (0Bh)

INT1 pin control register (R/W)

Each bit in this register enables a signal to be carried over INT1. The pin's output supplies the OR combination of the selected signals.

Table 277. FSM_INT1 register

INT1_FSM8	INT1_FSM7	INT1_FSM6	INT1_FSM5	INT1_FSM4	INT1_FSM3	INT1_FSM2	INT1_FSM1

Table 278. FSM_INT1 register description

INT1_FSM8[1]	Routing FSM8 interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_FSM7[1]	Routing FSM7 interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_FSM6[1]	Routing FSM6 interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_FSM5[1]	Routing FSM5 interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_FSM4[1]	Routing FSM4 interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_FSM3[1]	Routing FSM3 interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_FSM2[1]	Routing FSM2 interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_FSM1[1]	Routing FSM1 interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)

1. *This bit is activated if the INT1_EMB_FUNC bit of MD1_CFG (5Eh) is set to 1.*

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13.9 MLC_INT1 (0Dh)

INT1 pin control register (R/W)

Each bit in this register enables a signal to be carried over INT1. The pin's output supplies the OR combination of the selected signals.

Table 279. MLC_INT1 register

0(1)	0(1)	0(1)	0(1)	INT1_MLC4	INT1_MLC3	INT1_MLC2	INT1_MLC1

1. *This bit must be set to 0 for the correct operation of the device.*

Table 280. MLC_INT1 register description

INT1_MLC4	Routing MLC4 interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_MLC3	Routing MLC3 interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_MLC2	Routing MLC2 interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT1_MLC1	Routing MLC1 interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)

13.10 EMB_FUNC_INT2 (0Eh)

INT2 pin control register (R/W)

Each bit in this register enables a signal to be carried over INT2. The pin's output supplies the OR combination of the selected signals.

Table 281. EMB_FUNC_INT2 register

INT2_ FSM_LC	0(1)	INT2_ SIG_MOT	INT2_TILT	INT2_STEP _DETECTOR	0(1)	0(1)	0(1)

1. *This bit must be set to 0 for the correct operation of the device.*

Table 282. EMB_FUNC_INT2 register description

INT2_FSM_LC(1)	Routing FSM long counter timeout interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_SIG_MOT(1)	Routing significant motion event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_TILT(1)	Routing tilt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_STEP_DETECTOR(1)	Routing pedometer step recognition event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)

1. *This bit is activated if the INT2_EMB_FUNC bit of MD2_CFG (5Fh) is set to 1.*

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13.11 FSM_INT2 (0Fh)

INT2 pin control register (R/W)

Each bit in this register enables a signal to be carried over INT2. The pin's output supplies the OR combination of the selected signals.

Table 283. FSM_INT2 register

INT2_FSM8	INT2_FSM7	INT2_FSM6	INT2_FSM5	INT2_FSM4	INT2_FSM3	INT2_FSM2	INT2_FSM1

Table 284. FSM_INT2 register description

INT2_FSM8[1]	Routing FSM8 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM7[1]	Routing FSM7 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM6[1]	Routing FSM6 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM5[1]	Routing FSM5 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM4[1]	Routing FSM4 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM3[1]	Routing FSM3 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM2[1]	Routing FSM2 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM1[1]	Routing FSM1 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)

1. *This bit is activated if the INT2_EMB_FUNC bit of MD2_CFG (5Fh) is set to 1.*

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13.12 MLC_INT2 (11h)

INT2 pin control register (R/W)

Each bit in this register enables a signal to be carried over INT2. The pin's output supplies the OR combination of the selected signals.

Table 285. MLC_INT2 register

0(1)	0(1)	0(1)	0(1)	INT2_MLC4	INT2_MLC3	INT2_MLC2	INT2_MLC1

1. *This bit must be set to 0 for the correct operation of the device.*

Table 286. MLC_INT2 register description

INT2_MLC4	Routing MLC4 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_MLC3	Routing MLC3 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_MLC2	Routing MLC2 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_MLC1	Routing MLC1 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)

13.13 EMB_FUNC_STATUS (12h)

Embedded function status register (R)

Table 287. EMB_FUNC_STATUS register

IS_FSM_LC	0	IS_SIGMOT	IS_TILT	IS_STEP_DET	0	0	0

Table 288. EMB_FUNC_STATUS register description

IS_FSM_LC	Interrupt status bit for FSM long counter timeout interrupt event. (1: interrupt detected; 0: no interrupt)
IS_SIGMOT	Interrupt status bit for significant motion detection (1: interrupt detected; 0: no interrupt)
IS_TILT	Interrupt status bit for tilt detection (1: interrupt detected; 0: no interrupt)
IS_STEP_DET	Interrupt status bit for step detection (1: interrupt detected; 0: no interrupt)

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13.14 FSM_STATUS (13h)

Finite state machine status register (R)

Table 289. FSM_STATUS register

IS_FSM8	IS_FSM7	IS_FSM6	IS_FSM5	IS_FSM4	IS_FSM3	IS_FSM2	IS_FSM1

Table 290. FSM_STATUS register description

IS_FSM8	Interrupt status bit for FSM8 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM7	Interrupt status bit for FSM7 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM6	Interrupt status bit for FSM6 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM5	Interrupt status bit for FSM5 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM4	Interrupt status bit for FSM4 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM3	Interrupt status bit for FSM3 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM2	Interrupt status bit for FSM2 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM1	Interrupt status bit for FSM1 interrupt event. (1: interrupt detected; 0: no interrupt)

13.15 MLC_STATUS (15h)

Machine learning core status register (R)

Table 291. MLC_STATUS register

0	0	0	0	IS_MLC4	IS_MLC3	IS_MLC2	IS_MLC1

Table 292. MLC_STATUS register description

IS_MLC4	Interrupt status bit for MLC4 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_MLC3	Interrupt status bit for MLC3 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_MLC2	Interrupt status bit for MLC2 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_MLC1	Interrupt status bit for MLC1 interrupt event. (1: interrupt detected; 0: no interrupt)

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13.16 PAGE_RW (17h)

Enable read and write mode of advanced features dedicated page (R/W)

Table 293. PAGE_RW register

EMB_ FUNC_LIR	PAGE_ WRITE	PAGE_ READ	0(1)	0(1)	0(1)	0(1)	0(1)

1. *This bit must be set to 0 for the correct operation of the device.*

Table 294. PAGE_RW register description

EMB_FUNC_LIR	Latched interrupt mode for embedded functions. Default value: 0 (0: embedded functions interrupt request not latched; 1: embedded functions interrupt request latched)
PAGE_WRITE	Enables writes to the selected advanced features dedicated page.(1) Default value: 0 (1: enable; 0: disable)
PAGE_READ	Enables reads from the selected advanced features dedicated page.(1) Default value: 0 (1: enable; 0: disable)

1. *Page selected by PAGE_SEL[3:0] in PAGE_SEL (02h) register.*

13.17 EMB_FUNC_FIFO_EN_A (44h)

Embedded functions FIFO configuration register A (R/W)

Table 295. EMB_FUNC_FIFO_EN_A register

MLC_ FIFO_EN	STEP_COUNTER _FIFO_EN	SFLP_GBIAS _FIFO_EN	SFLP_GRAVITY _FIFO_EN	0(1)	0(1)	SFLP_GAME _FIFO_EN	0(1)

1. *This bit must be set to 0 for the correct operation of the device.*

Table 296. EMB_FUNC_FIFO_EN_A register description

MLC_FIFO_EN	Enables batching the machine learning core results in the FIFO buffer. Default value: 0 (0: disabled; 1: enabled)
STEP_COUNTER_FIFO_EN	Enables batching the step counter values in the FIFO buffer. Default value: 0 (0: disabled; 1: enabled)
SFLP_GBIAS_FIFO_EN	Enables batching the gyroscope bias values computed by the SFLP algorithm in the FIFO buffer. Default value: 0 (0: disabled; 1: enabled)
SFLP_GRAVITY_FIFO_EN	Enables batching the gravity values computed by the SFLP algorithm in the FIFO buffer. Default value: 0 (0: disabled; 1: enabled)
SFLP_GAME_FIFO_EN	Enables batching the game rotation vector (quaternion) values computed by the SFLP algorithm in the FIFO buffer. Default value: 0 (0: disabled; 1: enabled)

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13.18 EMB_FUNC_FIFO_EN_B (45h)

Embedded functions FIFO configuration register B (R/W)

Table 297. EMB_FUNC_FIFO_EN_B register

0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	MLC_FILTER_FEATURE_FIFO_EN	0(1)

1. *This bit must be set to 0 for the correct operation of the device.*

Table 298. EMB_FUNC_FIFO_EN_B register description

MLC_FILTER_FEATURE_FIFO_EN	Enables batching the machine learning core filters and features in the FIFO buffer. Default value: 0 (0: disabled; 1: enabled)

13.19 FSM_ENABLE (46h)

Enable FSM register (R/W)

Table 299. FSM_ENABLE register

FSM8_EN	FSM7_EN	FSM6_EN	FSM5_EN	FSM4_EN	FSM3_EN	FSM2_EN	FSM1_EN

Table 300. FSM_ENABLE register description

FSM8_EN	Enables FSM8. Default value: 0 (0: FSM8 disabled; 1: FSM8 enabled)
FSM7_EN	Enables FSM7. Default value: 0 (0: FSM7 disabled; 1: FSM7 enabled)
FSM6_EN	Enables FSM6. Default value: 0 (0: FSM6 disabled; 1: FSM6 enabled)
FSM5_EN	Enables FSM5. Default value: 0 (0: FSM5 disabled; 1: FSM5 enabled)
FSM4_EN	Enables FSM4. Default value: 0 (0: FSM4 disabled; 1: FSM4 enabled)
FSM3_EN	Enables FSM3. Default value: 0 (0: FSM3 disabled; 1: FSM3 enabled)
FSM2_EN	Enables FSM2. Default value: 0 (0: FSM2 disabled; 1: FSM2 enabled)
FSM1_EN	Enables FSM1. Default value: 0 (0: FSM1 disabled; 1: FSM1 enabled)

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13.20 FSM_LONG_COUNTER_L (48h) and FSM_LONG_COUNTER_H (49h)

FSM long counter status register (R/W)

The long counter value is an unsigned integer value (16-bit format).

Table 301. FSM_LONG_COUNTER_L register

FSM_LC_7	FSM_LC_6	FSM_LC_5	FSM_LC_4	FSM_LC_3	FSM_LC_2	FSM_LC_1	FSM_LC_0

Table 302. FSM_LONG_COUNTER_L register description

FSM_LC_[7:0]	Long counter current value (LSbyte). Default value: 00000000

Table 303. FSM_LONG_COUNTER_H register

FSM_LC_15	FSM_LC_14	FSM_LC_13	FSM_LC_12	FSM_LC_11	FSM_LC_10	FSM_LC_9	FSM_LC_8

Table 304. FSM_LONG_COUNTER_H register description

FSM_LC_[15:8]	Long counter current value (MSbyte). Default value: 00000000

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13.21 INT_ACK_MASK (4Bh)

Reset status register (R/W)

Table 305. INT_ACK_MASK register

IACK_ MASK7	IACK_ MASK6	IACK_ MASK5	IACK_ MASK4	IACK_ MASK3	IACK_ MASK2	IACK_ MASK1	IACK_ MASK0

Table 306. INT_ACK_MASK register description

IACK_MASK7	If set to 1, when reading the EMB_FUNC_STATUS (12h) / EMB_FUNC_STATUS_MAINPAGE (49h), FSM_STATUS (13h) / FSM_STATUS_MAINPAGE (4Ah) and MLC_STATUS (15h) / MLC_STATUS_MAINPAGE (4Bh) registers in latched mode (when the EMB_FUNC_LIR bit is set to 1 in the PAGE_RW (17h) register), bit 7 of the status register is not reset. When this bit is set to 0, bit 7 of the status register is reset. Default value: 0
IACK_MASK6	If set to 1, when reading the EMB_FUNC_STATUS (12h) / EMB_FUNC_STATUS_MAINPAGE (49h), FSM_STATUS (13h) / FSM_STATUS_MAINPAGE (4Ah) and MLC_STATUS (15h) / MLC_STATUS_MAINPAGE (4Bh) registers in latched mode (when the EMB_FUNC_LIR bit is set to 1 in the PAGE_RW (17h) register), bit 6 of the status register is not reset. When this bit is set to 0, bit 6 of the status register is reset. Default value: 0
IACK_MASK5	If set to 1, when reading the EMB_FUNC_STATUS (12h) / EMB_FUNC_STATUS_MAINPAGE (49h), FSM_STATUS (13h) / FSM_STATUS_MAINPAGE (4Ah) and MLC_STATUS (15h) / MLC_STATUS_MAINPAGE (4Bh) registers in latched mode (when the EMB_FUNC_LIR bit is set to 1 in the PAGE_RW (17h) register), bit 5 of the status register is not reset. When this bit is set to 0, bit 5 of the status register is reset. Default value: 0
IACK_MASK4	If set to 1, when reading the EMB_FUNC_STATUS (12h) / EMB_FUNC_STATUS_MAINPAGE (49h), FSM_STATUS (13h) / FSM_STATUS_MAINPAGE (4Ah) and MLC_STATUS (15h) / MLC_STATUS_MAINPAGE (4Bh) registers in latched mode (when the EMB_FUNC_LIR bit is set to 1 in the PAGE_RW (17h) register), bit 4 of the status register is not reset. When this bit is set to 0, bit 4 of the status register is reset. Default value: 0
IACK_MASK3	If set to 1, when reading the EMB_FUNC_STATUS (12h) / EMB_FUNC_STATUS_MAINPAGE (49h), FSM_STATUS (13h) / FSM_STATUS_MAINPAGE (4Ah) and MLC_STATUS (15h) / MLC_STATUS_MAINPAGE (4Bh) registers in latched mode (when the EMB_FUNC_LIR bit is set to 1 in the PAGE_RW (17h) register), bit 3 of the status register is not reset. When this bit is set to 0, bit 3 of the status register is reset. Default value: 0
IACK_MASK2	If set to 1, when reading the EMB_FUNC_STATUS (12h) / EMB_FUNC_STATUS_MAINPAGE (49h), FSM_STATUS (13h) / FSM_STATUS_MAINPAGE (4Ah) and MLC_STATUS (15h) / MLC_STATUS_MAINPAGE (4Bh) registers in latched mode (when the EMB_FUNC_LIR bit is set to 1 in the PAGE_RW (17h) register), bit 2 of the status register is not reset. When this bit is set to 0, bit 2 of the status register is reset. Default value: 0
IACK_MASK1	If set to 1, when reading the EMB_FUNC_STATUS (12h) / EMB_FUNC_STATUS_MAINPAGE (49h), FSM_STATUS (13h) / FSM_STATUS_MAINPAGE (4Ah) and MLC_STATUS (15h) / MLC_STATUS_MAINPAGE (4Bh) registers in latched mode (when the EMB_FUNC_LIR bit is set to 1 in the PAGE_RW (17h) register), bit 1 of the status register is not reset. When this bit is set to 0, bit 1 of the status register is reset. Default value: 0
IACK_MASK0	If set to 1, when reading the EMB_FUNC_STATUS (12h) / EMB_FUNC_STATUS_MAINPAGE (49h), FSM_STATUS (13h) / FSM_STATUS_MAINPAGE (4Ah) and MLC_STATUS (15h) / MLC_STATUS_MAINPAGE (4Bh) registers in latched mode (when the EMB_FUNC_LIR bit is set to 1 in the PAGE_RW (17h) register), bit 0 of the status register is not reset. When this bit is set to 0, bit 0 of the status register is reset. Default value: 0

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13.22 FSM_OUTS1 (4Ch)

FSM1 output register (R)

Table 307. FSM_OUTS1 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 308. FSM_OUTS1 register description

P_X	FSM1 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM1 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM1 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM1 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM1 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM1 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM1 output: positive event detected on the vector. (0: event not detected; 1: event detected)
N_V	FSM1 output: negative event detected on the vector. (0: event not detected; 1: event detected)

13.23 FSM_OUTS2 (4Dh)

FSM2 output register (R)

Table 309. FSM_OUTS2 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 310. FSM_OUTS2 register description

P_X	FSM2 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM2 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM2 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM2 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM2 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM2 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM2 output: positive event detected on the vector. (0: event not detected; 1: event detected)
N_V	FSM2 output: negative event detected on the vector. (0: event not detected; 1: event detected)

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13.24 FSM_OUTS3 (4Eh)

FSM3 output register (R)

Table 311. FSM_OUTS3 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 312. FSM_OUTS3 register description

P_X	FSM3 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM3 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM3 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM3 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM3 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM3 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM3 output: positive event detected on the vector. (0: event not detected; 1: event detected)
N_V	FSM3 output: negative event detected on the vector. (0: event not detected; 1: event detected)

13.25 FSM_OUTS4 (4Fh)

FSM4 output register (R)

Table 313. FSM_OUTS4 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 314. FSM_OUTS4 register description

P_X	FSM4 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM4 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM4 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM4 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM4 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM4 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM4 output: positive event detected on the vector. (0: event not detected; 1: event detected)
N_V	FSM4 output: negative event detected on the vector. (0: event not detected; 1: event detected)

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13.26 FSM_OUTS5 (50h)

FSM5 output register (R)

Table 315. FSM_OUTS5 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 316. FSM_OUTS5 register description

P_X	FSM5 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM5 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM5 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM5 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM5 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM5 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM5 output: positive event detected on the vector. (0: event not detected; 1: event detected)
N_V	FSM5 output: negative event detected on the vector. (0: event not detected; 1: event detected)

13.27 FSM_OUTS6 (51h)

FSM6 output register (R)

Table 317. FSM_OUTS6 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 318. FSM_OUTS6 register description

P_X	FSM6 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM6 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM6 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM6 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM6 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM6 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM6 output: positive event detected on the vector. (0: event not detected; 1: event detected)
N_V	FSM6 output: negative event detected on the vector. (0: event not detected; 1: event detected)

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13.28 FSM_OUTS7 (52h)

FSM7 output register (R)

Table 319. FSM_OUTS7 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 320. FSM_OUTS7 register description

P_X	FSM7 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM7 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM7 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM7 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM7 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM7 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM7 output: positive event detected on the vector. (0: event not detected; 1: event detected)
N_V	FSM7 output: negative event detected on the vector. (0: event not detected; 1: event detected)

13.29 FSM_OUTS8 (53h)

FSM8 output register (R)

Table 321. FSM_OUTS8 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 322. FSM_OUTS8 register description

P_X	FSM8 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM8 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM8 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM8 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM8 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM8 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM8 output: positive event detected on the vector. (0: event not detected; 1: event detected)
N_V	FSM8 output: negative event detected on the vector. (0: event not detected; 1: event detected)

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13.30 SFLP_ODR (5Eh)

Sensor fusion low-power output data rate configuration register (R/W)

Table 323. SFLP_ODR register

0(1)	1(2)	SFLP_GAME_ODR_2	SFLP_GAME_ODR_1	SFLP_GAME_ODR_0	0(1)	1(2)	1(2)

1. *This bit must be set to 0 for the correct operation of the device.*
2. *This bit must be set to 1 for the correct operation of the device.*

Table 324. SFLP_ODR register description

SFLP_GAME_ODR_[2:0]	ODR configuration of the SFLP game algorithm: (000: 15 Hz; 001: 30 Hz; 010: 60 Hz; 011: 120 Hz (default); 100: 240 Hz; 101: 480 Hz)

13.31 FSM_ODR (5Fh)

Finite state machine output data rate configuration register (R/W)

Table 325. FSM_ODR register

0(1)	1(2)	FSM_ODR_2	FSM_ODR_1	FSM_ODR_0	0(1)	1(2)	1(2)

1. *This bit must be set to 0 for the correct operation of the device.*
2. *This bit must be set to 1 for the correct operation of the device.*

Table 326. FSM_ODR register description

FSM_ODR_[2:0]	Finite state machine ODR configuration: (000: 15 Hz; 001: 30 Hz (default); 010: 60 Hz; 011: 120 Hz; 100: 240 Hz; 101: 480 Hz; 110: 960 Hz)

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13.32 MLC_ODR (60h)

Machine learning core output data rate configuration register (R/W)

Table 327. MLC_ODR register

0(1)	MLC_ODR_2	MLC_ODR_1	MLC_ODR_0	0(1)	1(2)	0(1)	1(2)

1. *This bit must be set to 0 for the correct operation of the device.*
2. *This bit must be set to 1 for the correct operation of the device.*

Table 328. MLC_ODR register description

MLC_ODR_[2:0]	Machine learning core ODR configuration: (000: 15 Hz; 001: 30 Hz (default); 010: 60 Hz; 011: 120 Hz; 100: 240 Hz)

13.33 STEP_COUNTER_L (62h) and STEP_COUNTER_H (63h)

Step counter output register (R)

Table 329. STEP_COUNTER_L register

STEP_7	STEP_6	STEP_5	STEP_4	STEP_3	STEP_2	STEP_1	STEP_0

Table 330. STEP_COUNTER_L register description

STEP_[7:0]	Step counter output (LSbyte)

Table 331. STEP_COUNTER_H register

STEP_15	STEP_14	STEP_13	STEP_12	STEP_11	STEP_10	STEP_9	STEP_8

Table 332. STEP_COUNTER_H register description

STEP_[15:8]	Step counter output (MSbyte)

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13.34 EMB_FUNC_SRC (64h)

Embedded function source register (R/W)

Table 333. EMB_FUNC_SRC register

PEDO_ RST_STEP	0(1)	STEP_ DETECTED	STEP_COUNT _DELTA_IA	STEP_ OVERFLOW	STEPCOUNTER _BIT_SET	0(1)	0(1)

1. *This bit must be set to 0 for the correct operation of the device.*

Table 334. EMB_FUNC_SRC register description

PEDO_RST_STEP	Reset pedometer step counter. Read/write bit. (0: disabled; 1: enabled)
STEP_DETECTED	Step detector event detection status. Read-only bit. (0: step detection event not detected; 1: step detection event detected)
STEP_COUNT_DELTA_IA	Pedometer step recognition on delta time status. Read-only bit. (0: no step recognized during delta time; 1: at least one step recognized during delta time)
STEP_OVERFLOW	Step counter overflow status. Read-only bit. (0: step counter value < 2^{16}; 1: step counter value reached 2^{16})
STEPCOUNTER_BIT_SET	This bit is equal to 1 when the step count is increased. If a timer period is programmed in PEDO_SC_DELTAT_L (D0h) and PEDO_SC_DELTAT_H (D1h) embedded advanced features (page 1) registers, this bit is kept at 0. Read-only bit.

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13.35 EMB_FUNC_INIT_A (66h)

Embedded functions initialization register (R/W)

Table 335. EMB_FUNC_INIT_A register

MLC_BEFORE_FSM_INIT	0(1)	SIG_MOT_INIT	TILT_INIT	STEP_DET_INIT	0(1)	SFLP_GAME_INIT	0(1)

1. *This bit must be set to 0 for the correct operation of the device.*

Table 336. EMB_FUNC_INIT_A register description

MLC_BEFORE_FSM_INIT	Machine learning core initialization request (MLC executed before FSM). Default value: 0
SIG_MOT_INIT	Significant motion detection algorithm initialization request. Default value: 0
TILT_INIT	Tilt algorithm initialization request. Default value: 0
STEP_DET_INIT	Pedometer step counter/detector algorithm initialization request. Default value: 0
SFLP_GAME_INIT	SFLP game algorithm initialization request. Default value: 0

13.36 EMB_FUNC_INIT_B (67h)

Embedded functions initialization register (R/W)

Table 337. EMB_FUNC_INIT_B register

0(1)	0(1)	0(1)	MLC_INIT	FIFO_COMPR_INIT	0(1)	0(1)	FSM_INIT

1. *This bit must be set to 0 for the correct operation of the device.*

Table 338. EMB_FUNC_INIT_B register description

MLC_INIT	Machine learning core initialization request (MLC executed after FSM). Default value: 0
FIFO_COMPR_INIT	FIFO compression feature initialization request. Default value: 0
FSM_INIT	FSM initialization request. Default value: 0

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13.37 MLC1_SRC (70h)

Machine learning core source register (R)

Table 339. MLC1_SRC register

MLC1_SRC_7	MLC1_SRC_6	MLC1_SRC_5	MLC1_SRC_4	MLC1_SRC_3	MLC1_SRC_2	MLC1_SRC_1	MLC1_SRC_0

Table 340. MLC1_SRC register description

MLC1_SRC_[7:0]	Output value of MLC1 decision tree

13.38 MLC2_SRC (71h)

Machine learning core source register (R)

Table 341. MLC2_SRC register

MLC2_SRC_7	MLC2_SRC_6	MLC2_SRC_5	MLC2_SRC_4	MLC2_SRC_3	MLCS2_SRC_2	MLC2_SRC_1	MLC2_SRC_0

Table 342. MLC2_SRC register description

MLC2_SRC_[7:0]	Output value of MLC2 decision tree

13.39 MLC3_SRC (72h)

Machine learning core source register (R)

Table 343. MLC3_SRC register

MLC3_SRC_7	MLC3_SRC_6	MLC3_SRC_5	MLC3_SRC_4	MLC3_SRC_3	MLC3_SRC_2	MLC3_SRC_1	MLC3_SRC_0

Table 344. MLC3_SRC register description

MLC3_SRC_[7:0]	Output value of MLC3 decision tree

13.40 MLC4_SRC (73h)

Machine learning core source register (R)

Table 345. MLC4_SRC register

MLC4_SRC_7	MLC4_SRC_6	MLC4_SRC_5	MLC4_SRC_4	MLC4_SRC_3	MLC4_SRC_2	MLC4_SRC_1	MLC4_SRC_0

Table 346. MLC4_SRC register description

MLC4_SRC_[7:0]	Output value of MLC4 decision tree

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14 Embedded advanced features pages

The table given below provides a list of the registers for the embedded advanced features page 0. These registers are accessible when PAGE_SEL[3:0] are set to 0000 in PAGE_SEL (02h).

Note: External sensor offset compensation registers and transformation matrix correction registers affect FSM data only. When these registers are set with their default values, no compensation is applied.

Table 347. Register address map - embedded advanced features page 0

Name	Type	Register address		Default	Comment
		Hex	Binary		
SFLP_GAME_GBIASX_L	R/W	6E	01101110	00000000	
SFLP_GAME_GBIASX_H	R/W	6F	01101111	00000000	
SFLP_GAME_GBIASY_L	R/W	70	01110000	00000000	
SFLP_GAME_GBIASY_H	R/W	71	01110001	00000000	
SFLP_GAME_GBIASZ_L	R/W	72	01110010	00000000	
SFLP_GAME_GBIASZ_H	R/W	73	01110011	00000000	
FSM_EXT_SENSITIVITY_L	R/W	BA	10111010	00100100	
FSM_EXT_SENSITIVITY_H	R/W	BB	10111011	00010110	
FSM_EXT_OFFX_L	R/W	C0	11000000	00000000	
FSM_EXT_OFFX_H	R/W	C1	11000001	00000000	
FSM_EXT_OFFY_L	R/W	C2	11000010	00000000	
FSM_EXT_OFFY_H	R/W	C3	11000011	00000000	
FSM_EXT_OFFZ_L	R/W	C4	11000100	00000000	
FSM_EXT_OFFZ_H	R/W	C5	11000101	00000000	
FSM_EXT_MATRIX_XX_L	R/W	C6	11000110	00000000	
FSM_EXT_MATRIX_XX_H	R/W	C7	11000111	00111100	
FSM_EXT_MATRIX_XY_L	R/W	C8	11001000	00000000	
FSM_EXT_MATRIX_XY_H	R/W	C9	11001001	00000000	
FSM_EXT_MATRIX_XZ_L	R/W	CA	11001010	00000000	
FSM_EXT_MATRIX_XZ_H	R/W	CB	11001011	00000000	
FSM_EXT_MATRIX_YY_L	R/W	CC	11001100	00000000	
FSM_EXT_MATRIX_YY_H	R/W	CD	11001101	00111100	
FSM_EXT_MATRIX_YZ_L	R/W	CE	11001110	00000000	
FSM_EXT_MATRIX_YZ_H	R/W	CF	11001111	00000000	
FSM_EXT_MATRIX_ZZ_L	R/W	D0	11010000	00000000	
FSM_EXT_MATRIX_ZZ_H	R/W	D1	11010001	00111100	
EXT_CFG_A	R/W	D4	11010100	00000101	
EXT_CFG_B	R/W	D5	11010101	00000010	

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The following table provides a list of the registers for the embedded advanced features page 1. These registers are accessible when PAGE_SEL[3:0] are set to 0001 in PAGE_SEL (02h).

Table 348. Register address map - embedded advanced features page 1

Name	Type	Register address		Default	Comment
		Hex	Binary		
FSM_LC_TIMEOUT_L	R/W	7A	01111010	00000000	
FSM_LC_TIMEOUT_H	R/W	7B	01111011	00000000	
FSM_PROGRAMS	R/W	7C	01111100	00000000	
FSM_START_ADD_L	R/W	7E	01111110	00000000	
FSM_START_ADD_H	R/W	7F	01111111	00000000	
PEDO_CMD_REG	R/W	83	10000011	00000000	
PEDO_DEB_STEPS_CONF	R/W	84	10000100	00001010	
PEDO_SC_DELTAT_L	R/W	D0	11010000	00000000	
PEDO_SC_DELTAT_H	R/W	D1	11010001	00000000	
MLC_EXT_SENSITIVITY_L	R/W	E8	11101000	00000000	
MLC_EXT_SENSITIVITY_H	R/W	E9	11101001	00111100	

The following table provides a list of the registers for the embedded advanced features page 2. These registers are accessible when PAGE_SEL[3:0] are set to 0010 in PAGE_SEL (02h).

Table 349. Register address map - embedded advanced features page 2

Name	Type	Register address		Default	Comment
		Hex	Binary		
EXT_FORMAT	R/W	00	00000000	00000000	
EXT_3BYTE_SENSITIVITY_L	R/W	02	00000010	00000000	
EXT_3BYTE_SENSITIVITY_H	R/W	03	00000011	00001100	
EXT_3BYTE_OFFSET_XL	R/W	06	00000110	00000000	
EXT_3BYTE_OFFSET_L	R/W	07	00000111	01010100	
EXT_3BYTE_OFFSET_H	R/W	08	00001000	00111111	

Reserved registers must not be changed. Writing to those registers may cause permanent damage to the device.

The content of the registers that are loaded at boot should not be changed. They contain the factory calibration values. Their content is automatically restored when the device is powered up.

Write procedure example: write value 06h in register at address 84h (PEDO_DEB_STEPS_CONF) in Page 1

1. Write bit EMB_FUNC_REG_ACCESS = 1 in FUNC_CFG_ACCESS (01h) // Enable access to embedded functions registers
2. Write bit PAGE_WRITE = 1 in PAGE_RW (17h) register // Select write operation mode
3. Write 0001 in PAGE_SEL[3:0] field of register PAGE_SEL (02h) // Select page 1
4. Write 84h in PAGE_ADDR register (08h) // Set address
5. Write 06h in PAGE_DATA register (09h) // Set value to be written
6. Write bit PAGE_WRITE = 0 in PAGE_RW (17h) register // Write operation disabled
7. Write bit EMB_FUNC_REG_ACCESS = 0 in FUNC_CFG_ACCESS (01h) // Disable access to embedded functions registers

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Read procedure example: read value of register at address 84h (PEDO_DEB_STEPS_CONF) in Page 1

1.	Write bit EMB_FUNC_REG_ACCESS = 1 in FUNC_CFG_ACCESS (01h)	// Enable access to embedded functions registers
2.	Write bit PAGE_READ = 1 in PAGE_RW (17h) register	// Select read operation mode
3.	Write 0001 in PAGE_SEL[3:0] field of register PAGE_SEL (02h)	// Select page 1
4.	Write 84h in PAGE_ADDR register (08h)	// Set address
5.	Read value of PAGE_DATA register (09h)	// Get register value
6.	Write bit PAGE_READ = 0 in PAGE_RW (17h) register	// Read operation disabled
7.	Write bit EMB_FUNC_REG_ACCESS = 0 in FUNC_CFG_ACCESS (01h)	// Disable access to embedded functions registers

Note: Steps 1 and 2 of both procedures are intended to be performed at the beginning of the procedure. Steps 6 and 7 of both procedures are intended to be performed at the end of the procedure. If the procedure involves multiple operations, only steps 3, 4 and 5 must be repeated for each operation. If, in particular, the multiple operations involve consecutive registers, only step 5 can be performed.

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15 Embedded advanced features register description

15.1 Page 0 - embedded advanced features registers

15.1.1 SFLP_GAME_GBIASX_L (6Eh) and SFLP_GAME_GBIASX_H (6Fh)

SFLP game algorithm X-axis gyroscope bias register (R/W)

The value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF (S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Table 350. SFLP_GAME_GBIASX_L register

GAME_GBIASX_7	GAME_GBIASX_6	GAME_GBIASX_5	GAME_GBIASX_4	GAME_GBIASX_3	GAME_GBIASX_2	GAME_GBIASX_1	GAME_GBIASX_0

Table 351. SFLP_GAME_GBIASX_L register description

GAME_GBIASX_[7:0]	SFLP game algorithm X-axis gbias: temporary register for gbias setting procedure (LSbyte). Default value: 00000000

Table 352. SFLP_GAME_GBIASX_H register

GAME_GBIASX_15	GAME_GBIASX_14	GAME_GBIASX_13	GAME_GBIASX_12	GAME_GBIASX_11	GAME_GBIASX_10	GAME_GBIASX_9	GAME_GBIASX_8

Table 353. SFLP_GAME_GBIASX_H register description

GAME_GBIASX_[15:8]	SFLP game algorithm X-axis gbias: temporary register for gbias setting procedure (MSbyte). Default value: 00000000

15.1.2 SFLP_GAME_GBIASY_L (70h) and SFLP_GAME_GBIASY_H (71h)

SFLP game algorithm Y-axis gyroscope bias register (R/W)

The value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF (S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Table 354. SFLP_GAME_GBIASY_L register

GAME_GBIASY_7	GAME_GBIASY_6	GAME_GBIASY_5	GAME_GBIASY_4	GAME_GBIASY_3	GAME_GBIASY_2	GAME_GBIASY_1	GAME_GBIASY_0

Table 355. SFLP_GAME_GBIASY_L register description

GAME_GBIASY_[7:0]	SFLP game algorithm Y-axis gbias: temporary register for gbias setting procedure (LSbyte). Default value: 00000000

Table 356. SFLP_GAME_GBIASY_H register

GAME_GBIASY_15	GAME_GBIASY_14	GAME_GBIASY_13	GAME_GBIASY_12	GAME_GBIASY_11	GAME_GBIASY_10	GAME_GBIASY_9	GAME_GBIASY_8

Table 357. SFLP_GAME_GBIASY_H register description

GAME_GBIASY_[15:8]	SFLP game algorithm Y-axis gbias: temporary register for gbias setting procedure (MSbyte). Default value: 00000000

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15.1.3 SFLP_GAME_GBIASZ_L (72h) and SFLP_GAME_GBIASZ_H (73h)

SFLP game algorithm Z-axis gyroscope bias register (R/W)

The value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF (S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Table 358. SFLP_GAME_GBIASZ_L register

GAME_GBIASZ_7	GAME_GBIASZ_6	GAME_GBIASZ_5	GAME_GBIASZ_4	GAME_GBIASZ_3	GAME_GBIASZ_2	GAME_GBIASZ_1	GAME_GBIASZ_0

Table 359. SFLP_GAME_GBIASZ_L register description

GAME_GBIASZ_[7:0]	SFLP game algorithm Z-axis gbias: temporary register for gbias setting procedure (LSbyte). Default value: 00000000

Table 360. SFLP_GAME_GBIASZ_H register

GAME_GBIASZ_15	GAME_GBIASZ_14	GAME_GBIASZ_13	GAME_GBIASZ_12	GAME_GBIASZ_11	GAME_GBIASZ_10	GAME_GBIASZ_9	GAME_GBIASZ_8

Table 361. SFLP_GAME_GBIASZ_H register description

GAME_GBIASZ_[15:8]	SFLP game algorithm Z-axis gbias: temporary register for gbias setting procedure (MSbyte). Default value: 00000000

15.1.4 FSM_EXT_SENSITIVITY_L (BAh) and FSM_EXT_SENSITIVITY_H (BBh)

External sensor sensitivity value register for the finite state machine (R/W)

This register corresponds to the conversion value of the external sensor. The register value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF (S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Default value of FSM_EXT_S_[15:0] bits is 0x1624 (when using an external magnetometer this value corresponds to 0.0015 gauss/LSB).

Table 362. FSM_EXT_SENSITIVITY_L register

FSM_EXT_S_7	FSM_EXT_S_6	FSM_EXT_S_5	FSM_EXT_S_4	FSM_EXT_S_3	FSM_EXT_S_2	FSM_EXT_S_1	FSM_EXT_S_0

Table 363. FSM_EXT_SENSITIVITY_L register description

FSM_EXT_S_[7:0]	External sensor sensitivity (LSbyte). Default value: 00100100

Table 364. FSM_EXT_SENSITIVITY_H register

FSM_EXT_S_15	FSM_EXT_S_14	FSM_EXT_S_13	FSM_EXT_S_12	FSM_EXT_S_11	FSM_EXT_S_10	FSM_EXT_S_9	FSM_EXT_S_8

Table 365. FSM_EXT_SENSITIVITY_H register description

FSM_EXT_S_[15:8]	External sensor (MSbyte). Default value: 00010110

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15.1.5 FSM_EXT_OFFX_L (C0h) and FSM_EXT_OFFX_H (C1h)

External sensor X-axis offset

The value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF

(S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Table 366. FSM_EXT_OFFX_L register

FSM_EXT_OFFX_7	FSM_EXT_OFFX_6	FSM_EXT_OFFX_5	FSM_EXT_OFFX_4	FSM_EXT_OFFX_3	FSM_EXT_OFFX_2	FSM_EXT_OFFX_1	FSM_EXT_OFFX_0

Table 367. FSM_EXT_OFFX_L register description

FSM_EXT_OFFX_[7:0]	External sensor X-axis offset (LSbyte). Default value: 00000000

Table 368. FSM_EXT_OFFX_H register

FSM_EXT_OFFX_15	FSM_EXT_OFFX_14	FSM_EXT_OFFX_13	FSM_EXT_OFFX_12	FSM_EXT_OFFX_11	FSM_EXT_OFFX_10	FSM_EXT_OFFX_9	FSM_EXT_OFFX_8

Table 369. FSM_EXT_OFFX_H register description

FSM_EXT_OFFX_[15:8]	External sensor X-axis offset (MSbyte). Default value: 00000000

15.1.6 FSM_EXT_OFFY_L (C2h) and FSM_EXT_OFFY_H (C3h)

External sensor Y-axis offset

The value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF

(S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Table 370. FSM_EXT_OFFY_L register

FSM_EXT_OFFY_7	FSM_EXT_OFFY_6	FSM_EXT_OFFY_5	FSM_EXT_OFFY_4	FSM_EXT_OFFY_3	FSM_EXT_OFFY_2	FSM_EXT_OFFY_1	FSM_EXT_OFFY_0

Table 371. FSM_EXT_OFFY_L register description

FSM_EXT_OFFY_[7:0]	External sensor Y-axis offset (LSbyte). Default value: 00000000

Table 372. FSM_EXT_OFFY_H register

FSM_EXT_OFFY_15	FSM_EXT_OFFY_14	FSM_EXT_OFFY_13	FSM_EXT_OFFY_12	FSM_EXT_OFFY_11	FSM_EXT_OFFY_10	FSM_EXT_OFFY_9	FSM_EXT_OFFY_8

Table 373. FSM_EXT_OFFY_H register description

FSM_EXT_OFFY_[15:8]	External sensor Y-axis offset (MSbyte). Default value: 00000000

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15.1.7 FSM_EXT_OFFZ_L (C4h) and FSM_EXT_OFFZ_H (C5h)

External sensor Z-axis offset register (R/W)

The value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF

(S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Table 374. FSM_EXT_OFFZ_L register

FSM_EXT_OFFZ_7	FSM_EXT_OFFZ_6	FSM_EXT_OFFZ_5	FSM_EXT_OFFZ_4	FSM_EXT_OFFZ_3	FSM_EXT_OFFZ_2	FSM_EXT_OFFZ_1	FSM_EXT_OFFZ_0

Table 375. FSM_EXT_OFFZ_L register description

FSM_EXT_OFFZ_[7:0]	External sensor Z-axis offset (LSbyte). Default value: 00000000

Table 376. FSM_EXT_OFFZ_H register

FSM_EXT_OFFZ_15	FSM_EXT_OFFZ_14	FSM_EXT_OFFZ_13	FSM_EXT_OFFZ_12	FSM_EXT_OFFZ_11	FSM_EXT_OFFZ_10	FSM_EXT_OFFZ_9	FSM_EXT_OFFZ_8

Table 377. FSM_EXT_OFFZ_H register description

FSM_EXT_OFFZ_[15:8]	External sensor Z-axis offset (MSbyte). Default value: 00000000

15.1.8 FSM_EXT_MATRIX_XX_L (C6h) and FSM_EXT_MATRIX_XX_H (C7h)

External sensor transformation matrix register (R/W)

The value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF

(S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Table 378. FSM_EXT_MATRIX_XX_L register

FSM_EXT_MAT_XX_7	FSM_EXT_MAT_XX_6	FSM_EXT_MAT_XX_5	FSM_EXT_MAT_XX_4	FSM_EXT_MAT_XX_3	FSM_EXT_MAT_XX_2	FSM_EXT_MAT_XX_1	FSM_EXT_XX_0

Table 379. FSM_EXT_MATRIX_XX_L register description

FSM_EXT_MAT_XX_[7:0]	Transformation matrix row1 col1 coefficient (LSbyte). Default value: 00000000

Table 380. FSM_EXT_MATRIX_XX_H register

FSM_EXT_MAT_XX_15	FSM_EXT_MAT_XX_14	FSM_EXT_MAT_XX_13	FSM_EXT_MAT_XX_12	FSM_EXT_MAT_XX_11	FSM_EXT_MAT_XX_10	FSM_EXT_XX_9	FSM_EXT_XX_8

Table 381. FSM_EXT_MATRIX_XX_H register description

FSM_EXT_MAT_[15:8]	Transformation matrix row1 col1 coefficient (MSbyte). Default value: 00111100

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15.1.9 FSM_EXT_MATRIX_XY_L (C8h) and FSM_EXT_MATRIX_XY_H (C9h)

External sensor transformation matrix register (R/W)
The value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF
(S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Table 382. FSM_EXT_MATRIX_XY_L register

FSM_EXT_MAT_XY_7	FSM_EXT_MAT_XY_6	FSM_EXT_MAT_XY_5	FSM_EXT_MAT_XY_4	FSM_EXT_MAT_XY_3	FSM_EXT_MAT_XY_2	FSM_EXT_MAT_XY_1	FSM_EXT_MAT_XY_0

Table 383. FSM_EXT_MATRIX_XY_L register description

FSM_EXT_MAT_XY_[7:0]	Transformation matrix row1 col2 (and row2 col1) coefficient (LSbyte). Default value: 00000000

Table 384. FSM_EXT_MATRIX_XY_H register

FSM_EXT_XY_15	FSM_EXT_XY_14	FSM_EXT_XY_13	FSM_EXT_XY_12	FSM_EXT_XY_11	FSM_EXT_XY_10	FSM_EXT_XY_9	FSM_EXT_XY_8

Table 385. FSM_EXT_MATRIX_XY_H register description

FSM_EXT_MAT_XY_[15:8]	Transformation matrix row1 col2 (and row2 col1) coefficient (MSbyte). Default value: 00000000

15.1.10 FSM_EXT_MATRIX_XZ_L (CAh) and FSM_EXT_MATRIX_XZ_H (CBh)

External sensor transformation matrix register (R/W)
The value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF
(S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Table 386. FSM_EXT_MATRIX_XZ_L register

FSM_EXT_MAT_XZ_7	FSM_EXT_MAT_XZ_6	FSM_EXT_MAT_XZ_5	FSM_EXT_MAT_XZ_4	FSM_EXT_MAT_XZ_3	FSM_EXT_MAT_XZ_2	FSM_EXT_MAT_XZ_1	FSM_EXT_MAT_XZ_0

Table 387. FSM_EXT_MATRIX_XZ_L register description

FSM_EXT_MAT_XZ_[7:0]	Transformation matrix row1 col3 (and row3 col1) coefficient (LSbyte). Default value: 00000000

Table 388. FSM_EXT_MATRIX_XZ_H register

FSM_EXT_MAT_XZ_15	FSM_EXT_MAT_XZ_14	FSM_EXT_MAT_XZ_13	FSM_EXT_MAT_XZ_12	FSM_EXT_MAT_XZ_11	FSM_EXT_MAT_XZ_10	FSM_EXT_MAT_XZ_9	FSM_EXT_MAT_XZ_8

Table 389. FSM_EXT_MATRIX_XZ_H register description

FSM_EXT_MAT_XZ_[15:8]	Transformation matrix row1 col3 (and row3 col1) coefficient (MSbyte). Default value: 00000000

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15.1.11 FSM_EXT_MATRIX_YY_L (CCh) and FSM_EXT_MATRIX_YY_H (CDh)

External sensor transformation matrix register (R/W)
The value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF
(S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Table 390. FSM_EXT_MATRIX_YY_L register

FSM_EXT_MAT_YY_7	FSM_EXT_MAT_YY_6	FSM_EXT_MAT_YY_5	FSM_EXT_MAT_YY_4	FSM_EXT_MAT_YY_3	FSM_EXT_MAT_YY_2	FSM_EXT_MAT_YY_1	FSM_EXT_MAT_YY_0

Table 391. FSM_EXT_MATRIX_YY_L register description

FSM_EXT_MAT_YY_[7:0]	Transformation matrix row2 col2 coefficient (LSbyte). Default value: 00000000

Table 392. FSM_EXT_MATRIX_YY_H register

FSM_EXT_MAT_YY_15	FSM_EXT_MAT_YY_14	FSM_EXT_MAT_YY_13	FSM_EXT_MAT_YY_12	FSM_EXT_MAT_YY_11	FSM_EXT_MAT_YY_10	FSM_EXT_MAT_YY_9	FSM_EXT_MAT_YY_8

Table 393. FSM_EXT_MATRIX_YY_H register description

FSM_EXT_MAT_YY_[15:8]	Transformation matrix row2 col2 coefficient (MSbyte). Default value: 00111100

15.1.12 FSM_EXT_MATRIX_YZ_L (CEh) and FSM_EXT_MATRIX_YZ_H (CFh)

External sensor transformation matrix register (R/W)
The value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF
(S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Table 394. FSM_EXT_MATRIX_YZ_L register

FSM_EXT_MAT_YZ_7	FSM_EXT_MAT_YZ_6	FSM_EXT_MAT_YZ_5	FSM_EXT_MAT_YZ_4	FSM_EXT_MAT_YZ_3	FSM_EXT_MAT_YZ_2	FSM_EXT_MAT_YZ_1	FSM_EXT_MAT_YZ_0

Table 395. FSM_EXT_MATRIX_YZ_L register description

FSM_EXT_MAT_YZ_[7:0]	Transformation matrix row2 col3 (and row3 col2) coefficient (LSbyte). Default value: 00000000

Table 396. FSM_EXT_MATRIX_YZ_H register

FSM_EXT_MAT_YZ_15	FSM_EXT_MAT_YZ_14	FSM_EXT_MAT_YZ_13	FSM_EXT_MAT_YZ_12	FSM_EXT_MAT_YZ_11	FSM_EXT_MAT_YZ_10	FSM_EXT_MAT_YZ_9	FSM_EXT_MAT_YZ_8

Table 397. FSM_EXT_MATRIX_YZ_H register description

FSM_EXT_MAT_YZ_[15:8]	Transformation matrix row2 col3 (and row3 col2) coefficient (MSbyte). Default value: 00000000

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15.1.13 FSM_EXT_MATRIX_ZZ_L (D0h) and FSM_EXT_MATRIX_ZZ_H (D1h)

External sensor transformation matrix register (R/W)

The value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF

(S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Table 398. FSM_EXT_MATRIX_ZZ_L register

FSM_EXT_MAT_ZZ_7	FSM_EXT_MAT_ZZ_6	FSM_EXT_MAT_ZZ_5	FSM_EXT_MAT_ZZ_4	FSM_EXT_MAT_ZZ_3	FSM_EXT_MAT_ZZ_2	FSM_EXT_MAT_ZZ_1	FSM_EXT_MAT_ZZ_0

Table 399. FSM_EXT_MATRIX_ZZ_L register description

FSM_EXT_MAT_ZZ_[7:0]	Transformation matrix row3 col3 coefficient (LSbyte). Default value: 00000000

Table 400. FSM_EXT_MATRIX_ZZ_H register

FSM_EXT_MAT_ZZ_15	FSM_EXT_MAT_ZZ_14	FSM_EXT_MAT_ZZ_13	FSM_EXT_MAT_ZZ_12	FSM_EXT_MAT_ZZ_11	FSM_EXT_MAT_ZZ_10	FSM_EXT_MAT_ZZ_9	FSM_EXT_MAT_ZZ_8

Table 401. FSM_EXT_MATRIX_ZZ_H register description

FSM_EXT_MAT_ZZ_[15:8]	Transformation matrix row3 col3 coefficient (MSbyte). Default value: 00111100

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15.1.14 EXT_CFG_A (D4h)

External sensor coordinates (Z and Y axes) rotation register (r/w).

Table 402. EXT_CFG_A register

0(1)	EXT_Y_ AXIS2	EXT_Y_ AXIS1	EXT_Y_ AXIS0	0(1)	EXT_Z_ AXIS2	EXT_Z_ AXIS1	EXT_Z_ AXIS0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 403. EXT_CFG_A description

EXT_Y_AXIS[2:0]	External sensor Y-axis coordinates rotation (to be aligned to accelerometer/gyroscope axes orientation) (000: Y = Y; (default) 001: Y = -Y; 010: Y = X; 011: Y = -X; 100: Y = -Z; 101: Y = Z; Others: Y = Y)
EXT_Z_AXIS[2:0]	External sensor Z-axis coordinates rotation (to be aligned to accelerometer/gyroscope axes orientation) (000: Z = Y; 001: Z = -Y; 010: Z = X; 011: Z = -X; 100: Z = -Z; 101: Z = Z; (default) Others: Z = Y)

15.1.15 EXT_CFG_B (D5h)

External sensor coordinates (X-axis) rotation register (r/w).

Table 404. EXT_CFG_B register

0(1)	0(1)	0(1)	0(1)	0(1)	EXT_X_ AXIS2	EXT_X_ AXIS1	EXT_X_ AXIS0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 405. EXT_CFG_B description

EXT_X_AXIS[2:0]	External sensor X-axis coordinates rotation (to be aligned to accelerometer/gyroscope axes orientation) (000: X = Y; 001: X = -Y; 010: X = X; (default) 011: X = -X; 100: X = -Z; 101: X = Z; Others: X = Y)

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15.2 Page 1 - embedded advanced features registers

15.2.1 FSM_LC_TIMEOUT_L (7Ah) and FSM_LC_TIMEOUT_H (7Bh)

FSM long counter timeout register (R/W)

The long counter timeout value is an unsigned integer value (16-bit format). When the long counter value reached this value, the FSM generates an interrupt.

Table 406. FSM_LC_TIMEOUT_L register

FSM_LC_TIMEOUT7	FSM_LC_TIMEOUT6	FSM_LC_TIMEOUT5	FSM_LC_TIMEOUT4	FSM_LC_TIMEOUT3	FSM_LC_TIMEOUT2	FSM_LC_TIMEOUT1	FSM_LC_TIMEOUT0

Table 407. FSM_LC_TIMEOUT_L register description

FSM_LC_TIMEOUT[7:0]	FSM long counter timeout value (LSbyte). Default value: 00000000

Table 408. FSM_LC_TIMEOUT_H register

FSM_LC_TIMEOUT15	FSM_LC_TIMEOUT14	FSM_LC_TIMEOUT13	FSM_LC_TIMEOUT12	FSM_LC_TIMEOUT11	FSM_LC_TIMEOUT10	FSM_LC_TIMEOUT9	FSM_LC_TIMEOUT8

Table 409. FSM_LC_TIMEOUT_H register description

FSM_LC_TIMEOUT[15:8]	FSM long counter timeout value (MSbyte). Default value: 00000000

15.2.2 FSM_PROGRAMS (7Ch)

FSM number of programs register (R/W)

Table 410. FSM_PROGRAMS register

FSM_N_PROG7	FSM_N_PROG6	FSM_N_PROG5	FSM_N_PROG4	FSM_N_PROG3	FSM_N_PROG2	FSM_N_PROG1	FSM_N_PROG0

Table 411. FSM_PROGRAMS register description

FSM_N_PROG[7:0]	Number of FSM programs; must be less than or equal to 8. Default value: 00000000

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15.2.3 FSM_START_ADD_L (7Eh) and FSM_START_ADD_H (7Fh)

FSM start address register (R/W). First available address is 0x35C.

Table 412. FSM_START_ADD_L register

FSM_START7	FSM_START6	FSM_START5	FSM_START4	FSM_START3	FSM_START2	FSM_START1	FSM_START0

Table 413. FSM_START_ADD_L register description

FSM_START[7:0]	FSM start address value (LSbyte). Default value: 00000000

Table 414. FSM_START_ADD_H register

FSM_START15	FSM_START14	FSM_START13	FSM_START12	FSM_START11	FSM_START10	FSM_START9	FSM_START8

Table 415. FSM_START_ADD_H register description

FSM_START[15:8]	FSM start address value (MSbyte). Default value: 00000000

15.2.4 PEDO_CMD_REG (83h)

Pedometer configuration register (R/W)

Table 416. PEDO_CMD_REG register

0(1)	0(1)	0(1)	0(1)	CARRY_COUNT_EN	FP_REJECTION_EN	0(1)	0(1)

1. *This bit must be set to 0 for the correct operation of the device.*

Table 417. PEDO_CMD_REG register description

CARRY_COUNT_EN	Set when user wants to generate interrupt only on count overflow event.
FP_REJECTION_EN(1)	Enables the false-positive rejection feature

1. *This bit is activated if the MLC_EN bit of EMB_FUNC_EN_B (05h) or the MLC_BEFORE_FSM_EN bit in the EMB_FUNC_EN_A (04h) register is set to 1.*

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15.2.5 PEDO_DEB_STEPS_CONF (84h)

Pedometer debounce configuration register (R/W)

Table 418. PEDO_DEB_STEPS_CONF register

DEB_ STEP7	DEB_ STEP6	DEB_ STEP5	DEB_ STEP4	DEB_ STEP3	DEB_ STEP2	DEB_ STEP1	DEB_ STEP0

Table 419. PEDO_DEB_STEPS_CONF register description

DEB_STEP[7:0]	Debounce threshold. Minimum number of steps to increment the step counter (debounce). Default value: 00001010

15.2.6 PEDO_SC_DELTAT_L (D0h) and PEDO_SC_DELTAT_H (D1h)

Time period register for step detection on delta time (R/W)

Table 420. PEDO_SC_DELTAT_L register

PD_SC_7	PD_SC_6	PD_SC_5	PD_SC_4	PD_SC_3	PD_SC_2	PD_SC_1	PD_SC_0

Table 421. PEDO_SC_DELTAT_H register

PD_SC_15	PD_SC_14	PD_SC_13	PD_SC_12	PD_SC_11	PD_SC_10	PD_SC_9	PD_SC_8

Table 422. PEDO_SC_DELTAT_H/L register description

PD_SC_[15:0]	Time period value (1LSB = 6.4 ms)

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15.2.7 MLC_EXT_SENSITIVITY_L (E8h) and MLC_EXT_SENSITIVITY_H (E9h)

External sensor sensitivity value register for the machine learning core (R/W)

This register corresponds to the conversion value of the external sensor. The register value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF (S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

Default value of MLC_EXT_S_[15:0] is 0x3C00 (when using an external magnetometer this value corresponds to 1 gauss/LSB).

Table 423. MLC_EXT_SENSITIVITY_L register

MLC_ EXT_S_7	MLC_ EXT_S_6	MLC_ EXT_S_5	MLC_ EXT_S_4	MLC_ EXT_S_3	MLC_ EXT_S_2	MLC_ EXT_S_1	MLC_ EXT_S_0

Table 424. MLC_ EXT_SENSITIVITY_L register description

MLC_EXT_S_[7:0]	External sensor sensitivity (LSbyte). Default value: 00000000

Table 425. MLC_EXT_SENSITIVITY_H register

MLC_ EXT_S_15	MLC_ EXT_S_14	MLC_ EXT_S_13	MLC_ EXT_S_12	MLC_ EXT_S_11	MLC_ EXT_S_10	MLC_ EXT_S_9	MLC_ EXT_S_8

Table 426. MLC_EXT_SENSITIVITY_H register description

MLC_EXT_S_[15:8]	External sensor sensitivity (MSbyte). Default value: 00111100

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15.3 Page 2 - embedded advanced features registers

15.3.1 EXT_FORMAT (00h)

AH / Qvar / external sensor data format (2-byte or 3-byte) for the finite state machine and machine learning core (R/W)

Table 427. EXT_FORMAT register

0(1)	0(1)	0(1)	0(1)	0(1)	EXT_FORMAT_SEL	0(1)	0(1)

1. *This bit must be set to 0 for the correct operation of the device.*

Table 428. EXT_FORMAT register description

EXT_FORMAT_SEL	Selects the format of AH / Qvar / external sensor data for FSM and MLC processing. Default value: 0 (0: 2-byte format; 1: 3-byte format)

15.3.2 EXT_3BYTE_SENSITIVITY_L (02h) and EXT_3BYTE_SENSITIVITY_H (03h)

External sensor (3-byte output data) sensitivity value register for the finite state machine and machine learning core (R/W)

This register corresponds to the conversion value of the external sensor having 3-byte output data. The register value is expressed as half-precision floating-point format: SEEEEEFFFFFFFFFF (S: 1 sign bit; E: 5 exponent bits; F: 10 fraction bits).

The default value of EXT_3BYTE_S_[15:0] is 0x0C00 (when using an external pressure sensor this value corresponds to 2.441e-04 hPa/LSB).

Table 429. EXT_3BYTE_SENSITIVITY_L register

EXT_3BYTE_S_7	EXT_3BYTE_S_6	EXT_3BYTE_S_5	EXT_3BYTE_S_4	EXT_3BYTE_S_3	EXT_3BYTE_S_2	EXT_3BYTE_S_1	EXT_3BYTE_S_0

Table 430. EXT_3BYTE_SENSITIVITY_L register description

EXT_3BYTE_S_[7:0]	External sensor (3-byte output data) sensitivity (LSbyte). Default value: 00000000

Table 431. EXT_3BYTE_SENSITIVITY_H register

EXT_3BYTE_S_15	EXT_3BYTE_S_14	EXT_3BYTE_S_13	EXT_3BYTE_S_12	EXT_3BYTE_S_11	EXT_3BYTE_S_10	EXT_3BYTE_S_9	EXT_3BYTE_S_8

Table 432. EXT_3BYTE_SENSITIVITY_H register description

EXT_3BYTE_S_[15:8]	External sensor (3-byte output data) sensitivity (MSbyte). Default value: 00001100

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15.3.3 EXT_3BYTE_OFFSET_XL (06h), EXT_3BYTE_OFFSET_L (07h) and EXT_3BYTE_OFFSET_H (08h)

External sensor (3-byte output data) offset value register for the finite state machine and machine learning core (R/W)

This register corresponds to the offset value applied to external sensor output data (3-byte) before being processed in FSM and MLC. The value is expressed as a 24-bit word in two's complement.

The default value of EXT_3BYTE_OFF_[23:0] is 0x3F5400, which corresponds to 4150272 LSB. This offset is subtracted from the external output data (in LSB) before the sensitivity (configured in the EXT_3BYTE_SENSITIVITY_L (02h) and EXT_3BYTE_SENSITIVITY_H (03h) registers) is internally applied.

Table 433. EXT_3BYTE_OFFSET_XL register

EXT_3BYTE_OFF_7	EXT_3BYTE_OFF_6	EXT_3BYTE_OFF_5	EXT_3BYTE_OFF_4	EXT_3BYTE_OFF_3	EXT_3BYTE_OFF_2	EXT_3BYTE_OFF_1	EXT_3BYTE_OFF_0

Table 434. EXT_3BYTE_OFFSET_XL register description

EXT_3BYTE_OFF_[7:0]	External sensor (3-byte output data) offset (low byte). Default value: 00000000

Table 435. EXT_3BYTE_OFFSET_L register

EXT_3BYTE_OFF_15	EXT_3BYTE_OFF_14	EXT_3BYTE_OFF_13	EXT_3BYTE_OFF_12	EXT_3BYTE_OFF_11	EXT_3BYTE_OFF_10	EXT_3BYTE_OFF_9	EXT_3BYTE_OFF_8

Table 436. EXT_3BYTE_OFFSET_L register description

EXT_3BYTE_OFF_[15:8]	External sensor (3-byte output data) offset (mid byte). Default value: 01010100

Table 437. EXT_3BYTE_OFFSET_H register

EXT_3BYTE_OFF_23	EXT_3BYTE_OFF_22	EXT_3BYTE_OFF_21	EXT_3BYTE_OFF_20	EXT_3BYTE_OFF_19	EXT_3BYTE_OFF_18	EXT_3BYTE_OFF_17	EXT_3BYTE_OFF_16

Table 438. EXT_3BYTE_OFFSET_H register description

EXT_3BYTE_OFF_[23:16]	External sensor (3-byte output data) offset (high byte). Default value: 00111111

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16 Sensor hub register mapping

The table given below provides a list of the registers for the sensor hub functions available in the device and the corresponding addresses. The sensor hub registers are accessible when bit SHUB_REG_ACCESS is set to 1 in FUNC_CFG_ACCESS (01h).

Table 439. Register address map - sensor hub registers

Name	Type	Register address		Default	Comment
		Hex	Binary		
SENSOR_HUB_1	R	02	00000010	output	
SENSOR_HUB_2	R	03	00000011	output	
SENSOR_HUB_3	R	04	00000100	output	
SENSOR_HUB_4	R	05	00000101	output	
SENSOR_HUB_5	R	06	00000110	output	
SENSOR_HUB_6	R	07	00000111	output	
SENSOR_HUB_7	R	08	00001000	output	
SENSOR_HUB_8	R	09	00001001	output	
SENSOR_HUB_9	R	0A	00001010	output	
SENSOR_HUB_10	R	0B	00001011	output	
SENSOR_HUB_11	R	0C	00001100	output	
SENSOR_HUB_12	R	0D	00001101	output	
SENSOR_HUB_13	R	0E	00001110	output	
SENSOR_HUB_14	R	0F	00001111	output	
SENSOR_HUB_15	R	10	00010000	output	
SENSOR_HUB_16	R	11	00010001	output	
SENSOR_HUB_17	R	12	00010010	output	
SENSOR_HUB_18	R	13	00010011	output	
MASTER_CONFIG	R/W	14	00010100	00000000	
SLV0_ADD	R/W	15	00010101	00000000	
SLV0_SUBADD	R/W	16	00010110	00000000	
SLV0_CONFIG	R/W	17	00010111	10000000	
SLV1_ADD	R/W	18	00011000	00000000	
SLV1_SUBADD	R/W	19	00011001	00000000	
SLV1_CONFIG	R/W	1A	00011010	00010000	
SLV2_ADD	R/W	1B	00011011	00000000	
SLV2_SUBADD	R/W	1C	00011100	00000000	
SLV2_CONFIG	R/W	1D	00011101	00000000	
SLV3_ADD	R/W	1E	00011110	00000000	
SLV3_SUBADD	R/W	1F	00011111	00000000	
SLV3_CONFIG	R/W	20	00100000	00000000	
DATAWRITE_SLV0	R/W	21	00100001	00000000	
STATUS_MASTER	R	22	00100010	output	

Reserved registers must not be changed. Writing to those registers may cause permanent damage to the device.

The content of the registers that are loaded at boot should not be changed. They contain the factory calibration values. Their content is automatically restored when the device is powered up.

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17 Sensor hub register description

17.1 SENSOR_HUB_1 (02h)

Sensor hub output register (R)

First byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 440. SENSOR_HUB_1 register

Sensor Hub1_7	Sensor Hub1_6	Sensor Hub1_5	Sensor Hub1_4	Sensor Hub1_3	Sensor Hub1_2	Sensor Hub1_1	Sensor Hub1_0

Table 441. SENSOR_HUB_1 register description

SensorHub1_[7:0]	First byte associated to external sensors

17.2 SENSOR_HUB_2 (03h)

Sensor hub output register (R)

Second byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 442. SENSOR_HUB_2 register

Sensor Hub2_7	Sensor Hub2_6	Sensor Hub2_5	Sensor Hub2_4	Sensor Hub2_3	Sensor Hub2_2	Sensor Hub2_1	Sensor Hub2_0

Table 443. SENSOR_HUB_2 register description

SensorHub2_[7:0]	Second byte associated to external sensors

17.3 SENSOR_HUB_3 (04h)

Sensor hub output register (R)

Third byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 444. SENSOR_HUB_3 register

Sensor Hub3_7	Sensor Hub3_6	Sensor Hub3_5	Sensor Hub3_4	Sensor Hub3_3	Sensor Hub3_2	Sensor Hub3_1	Sensor Hub3_0

Table 445. SENSOR_HUB_3 register description

SensorHub3_[7:0]	Third byte associated to external sensors

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17.4 SENSOR_HUB_4 (05h)

Sensor hub output register (R)

Fourth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 446. SENSOR_HUB_4 register

Sensor Hub4_7	Sensor Hub4_6	Sensor Hub4_5	Sensor Hub4_4	Sensor Hub4_3	Sensor Hub4_2	Sensor Hub4_1	Sensor Hub4_0

Table 447. SENSOR_HUB_4 register description

SensorHub4_[7:0]	Fourth byte associated to external sensors

17.5 SENSOR_HUB_5 (06h)

Sensor hub output register (R)

Fifth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 448. SENSOR_HUB_5 register

Sensor Hub5_7	Sensor Hub5_6	Sensor Hub5_5	Sensor Hub5_4	Sensor Hub5_3	Sensor Hub5_2	Sensor Hub5_1	Sensor Hub5_0

Table 449. SENSOR_HUB_5 register description

SensorHub5_[7:0]	Fifth byte associated to external sensors

17.6 SENSOR_HUB_6 (07h)

Sensor hub output register (R)

Sixth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 450. SENSOR_HUB_6 register

Sensor Hub6_7	Sensor Hub6_6	Sensor Hub6_5	Sensor Hub6_4	Sensor Hub6_3	Sensor Hub6_2	Sensor Hub6_1	Sensor Hub6_0

Table 451. SENSOR_HUB_6 register description

SensorHub6_[7:0]	Sixth byte associated to external sensors

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17.7 SENSOR_HUB_7 (08h)

Sensor hub output register (R)

Seventh byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 452. SENSOR_HUB_7 register

Sensor Hub7_7	Sensor Hub7_6	Sensor Hub7_5	Sensor Hub7_4	Sensor Hub7_3	Sensor Hub7_2	Sensor Hub7_1	Sensor Hub7_0

Table 453. SENSOR_HUB_7 register description

SensorHub7_[7:0]	Seventh byte associated to external sensors

17.8 SENSOR_HUB_8 (09h)

Sensor hub output register (R)

Eighth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 454. SENSOR_HUB_8 register

Sensor Hub8_7	Sensor Hub8_6	Sensor Hub8_5	Sensor Hub8_4	Sensor Hub8_3	Sensor Hub8_2	Sensor Hub8_1	Sensor Hub8_0

Table 455. SENSOR_HUB_8 register description

SensorHub8_[7:0]	Eighth byte associated to external sensors

17.9 SENSOR_HUB_9 (0Ah)

Sensor hub output register (R)

Ninth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 456. SENSOR_HUB_9 register

Sensor Hub9_7	Sensor Hub9_6	Sensor Hub9_5	Sensor Hub9_4	Sensor Hub9_3	Sensor Hub9_2	Sensor Hub9_1	Sensor Hub9_0

Table 457. SENSOR_HUB_9 register description

SensorHub9_[7:0]	Ninth byte associated to external sensors

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17.10 SENSOR_HUB_10 (0Bh)

Sensor hub output register (R)

Tenth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 458. SENSOR_HUB_10 register

Sensor Hub10_7	Sensor Hub10_6	Sensor Hub10_5	Sensor Hub10_4	Sensor Hub10_3	Sensor Hub10_2	Sensor Hub10_1	Sensor Hub10_0

Table 459. SENSOR_HUB_10 register description

SensorHub10_[7:0]	Tenth byte associated to external sensors

17.11 SENSOR_HUB_11 (0Ch)

Sensor hub output register (R)

Eleventh byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 460. SENSOR_HUB_11 register

Sensor Hub11_7	Sensor Hub11_6	Sensor Hub11_5	Sensor Hub11_4	Sensor Hub11_3	Sensor Hub11_2	Sensor Hub11_1	Sensor Hub11_0

Table 461. SENSOR_HUB_11 register description

SensorHub11_[7:0]	Eleventh byte associated to external sensors

17.12 SENSOR_HUB_12 (0Dh)

Sensor hub output register (R)

Twelfth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 462. SENSOR_HUB_12 register

Sensor Hub12_7	Sensor Hub12_6	Sensor Hub12_5	Sensor Hub12_4	Sensor Hub12_3	Sensor Hub12_2	Sensor Hub12_1	Sensor Hub12_0

Table 463. SENSOR_HUB_12 register description

SensorHub12_[7:0]	Twelfth byte associated to external sensors

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17.13 SENSOR_HUB_13 (0Eh)

Sensor hub output register (R)

Thirteenth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 464. SENSOR_HUB_13 register

Sensor Hub13_7	Sensor Hub13_6	Sensor Hub13_5	Sensor Hub13_4	Sensor Hub13_3	Sensor Hub13_2	Sensor Hub13_1	Sensor Hub13_0

Table 465. SENSOR_HUB_13 register description

SensorHub13_[7:0]	Thirteenth byte associated to external sensors

17.14 SENSOR_HUB_14 (0Fh)

Sensor hub output register (R)

Fourteenth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 466. SENSOR_HUB_14 register

Sensor Hub14_7	Sensor Hub14_6	Sensor Hub14_5	Sensor Hub14_4	Sensor Hub14_3	Sensor Hub14_2	Sensor Hub14_1	Sensor Hub14_0

Table 467. SENSOR_HUB_14 register description

SensorHub14_[7:0]	Fourteenth byte associated to external sensors

17.15 SENSOR_HUB_15 (10h)

Sensor hub output register (R)

Fifteenth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 468. SENSOR_HUB_15 register

Sensor Hub15_7	Sensor Hub15_6	Sensor Hub15_5	Sensor Hub15_4	Sensor Hub15_3	Sensor Hub15_2	Sensor Hub15_1	Sensor Hub15_0

Table 469. SENSOR_HUB_15 register description

SensorHub15_[7:0]	Fifteenth byte associated to external sensors

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17.16 SENSOR_HUB_16 (11h)

Sensor hub output register (R)

Sixteenth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 470. SENSOR_HUB_16 register

Sensor Hub16_7	Sensor Hub16_6	Sensor Hub16_5	Sensor Hub16_4	Sensor Hub16_3	Sensor Hub16_2	Sensor Hub16_1	Sensor Hub16_0

Table 471. SENSOR_HUB_16 register description

SensorHub16_[7:0]	Sixteenth byte associated to external sensors

17.17 SENSOR_HUB_17 (12h)

Sensor hub output register (R)

Seventeenth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 472. SENSOR_HUB_17 register

Sensor Hub17_7	Sensor Hub17_6	Sensor Hub17_5	Sensor Hub17_4	Sensor Hub17_3	Sensor Hub17_2	Sensor Hub17_1	Sensor Hub17_0

Table 473. SENSOR_HUB_17 register description

SensorHub17_[7:0]	Seventeenth byte associated to external sensors

17.18 SENSOR_HUB_18 (13h)

Sensor hub output register (R)

Eighteenth byte associated to external sensors. The content of the register is consistent with the SLVx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 474. SENSOR_HUB_17 register

Sensor Hub18_7	Sensor Hub18_6	Sensor Hub18_5	Sensor Hub18_4	Sensor Hub18_3	Sensor Hub18_2	Sensor Hub18_1	Sensor Hub18_0

Table 475. SENSOR_HUB_17 register description

SensorHub18_[7:0]	Eighteenth byte associated to external sensors

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17.19 MASTER_CONFIG (14h)

Master configuration register (R/W)

Table 476. MASTER_CONFIG register

RST_MASTER_REGS	WRITE_ONCE	START_CONFIG	PASS_THROUGH_MODE	0(1)	MASTER_ON	AUX_SENS_ON1	AUX_SENS_ON0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 477. MASTER_CONFIG register description

RST_MASTER_REGS	Resets master logic and output registers. Must be set to 1 and then set to 0. Default value: 0
WRITE_ONCE	Slave 0 write operation is performed only at the first sensor hub cycle. Default value: 0 (0: write operation for each sensor hub cycle; 1: write operation only for the first sensor hub cycle)
START_CONFIG	Sensor hub trigger signal selection. Default value: 0 (0: sensor hub trigger signal is the accelerometer/gyro data-ready; 1: sensor hub trigger signal external from INT2 pin)
PASS_THROUGH_MODE	I²C interface pass-through. Default value: 0 (0: pass-through disabled; 1: pass-through enabled, primary I²C line is short-circuited with the sensor hub line)
MASTER_ON	Enables sensor hub I²C master. Default: 0 (0: master I²C of sensor hub disabled; 1: master I²C of sensor hub enabled)
AUX_SENS_ON[1:0]	Number of external sensors to be read by the sensor hub. (00: one sensor (default); 01: two sensors; 10: three sensors; 11: four sensors)

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17.20 SLV0_ADD (15h)

I²C slave address of the first external sensor (sensor 0) register (R/W)

Table 478. SLV0_ADD register

slave0_add6	slave0_add5	slave0_add4	slave0_add3	slave0_add2	slave0_add1	slave0_add0	rw_0

Table 479. SLV_ADD register description

slave0_add[6:0]	I²C slave address of sensor 0 that can be read by the sensor hub. Default value: 0000000
rw_0	Read/write operation on sensor 0. Default value: 0 (0: write operation; 1: read operation)

17.21 SLV0_SUBADD (16h)

Address of register on the first external sensor (sensor 0) register (R/W)

Table 480. SLV0_SUBADD register

slave0_reg7	slave0_reg6	slave0_reg5	slave0_reg4	slave0_reg3	slave0_reg2	slave0_reg1	slave0_reg0

Table 481. SLV0_SUBADD register description

slave0_reg[7:0]	Address of register on sensor 0 that has to be read/written according to the rw_0 bit value in SLV0_ADD (15h). Default value: 00000000

17.22 SLV0_CONFIG (17h)

First external sensor (sensor 0) configuration and sensor hub settings register (R/W)

Table 482. SLV0_CONFIG register

SHUB_ ODR_2	SHUB_ ODR_1	SHUB_ ODR_0	0(1)	BATCH_EXT_ SENS_0_EN	Slave0_ numop2	Slave0_ numop1	Slave0_ numop0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 483. SLV0_CONFIG register description

SHUB_ODR_[2:0]	Rate at which the master communicates. (000: 1.875 Hz; 001: 15 Hz; 010: 30 Hz; 011: 60 Hz; 100: 120 Hz (default); 101: 240 Hz; 110: 480 Hz; 111: reserved
BATCH_EXT_SENS_0_EN	Enables FIFO data batching of first slave. Default value: 0
Slave0_numop[2:0]	Number of read operations on sensor 0. Default value: 000

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17.23 SLV1_ADD (18h)

I²C slave address of the second external sensor (sensor 1) register (R/W)

Table 484. SLV1_ADD register

Slave1_add6	Slave1_add5	Slave1_add4	Slave1_add3	Slave1_add2	Slave1_add1	Slave1_add0	r_1

Table 485. SLV1_ADD register description

Slave1_add[6:0]	I²C slave address of sensor 1 that can be read by the sensor hub. Default value: 0000000
r_1	Enables read operation on sensor 1. Default value: 0 (0: read operation disabled; 1: read operation enabled)

17.24 SLV1_SUBADD (19h)

Address of register on the second external sensor (sensor 1) register (R/W)

Table 486. SLV1_SUBADD register

Slave1_reg7	Slave1_reg6	Slave1_reg5	Slave1_reg4	Slave1_reg3	Slave1_reg2	Slave1_reg1	Slave1_reg0

Table 487. SLV1_SUBADD register description

Slave1_reg[7:0]	Address of register on sensor 1 that has to be read/written according to the r_1 bit value in SLV1_ADD (18h).

17.25 SLV1_CONFIG (1Ah)

Second external sensor (sensor 2) configuration register (R/W)

Table 488. SLV1_CONFIG register

0(1)	0(1)	0(1)	1(2)	BATCH_EXT_SENS_1_EN	Slave1_numop2	Slave1_numop1	Slave1_numop0

1. *This bit must be set to 0 for the correct operation of the device.*
2. *This bit must be set to 1 for the correct operation of the device.*

Table 489. SLV1_CONFIG register description

BATCH_EXT_SENS_1_EN	Enables FIFO data batching of second slave. Default value: 0
Slave1_numop[2:0]	Number of read operations on sensor 2. Default value: 000

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17.26 SLV2_ADD (1Bh)

I²C slave address of the third external sensor (sensor 2) register (R/W)

Table 490. SLV2_ADD register

Slave2_add6	Slave2_add5	Slave2_add4	Slave2_add3	Slave2_add2	Slave2_add1	Slave2_add0	r_2

Table 491. SLV2_ADD register description

Slave2_add[6:0]	I²C slave address of sensor 2 that can be read by the sensor hub.
r_2	Enables read operation on sensor 2. Default value: 0 (0: read operation disabled; 1: read operation enabled)

17.27 SLV2_SUBADD (1Ch)

Address of register on the third external sensor (sensor 2) register (R/W)

Table 492. SLV2_SUBADD register

Slave2_reg7	Slave2_reg6	Slave2_reg5	Slave2_reg4	Slave2_reg3	Slave2_reg2	Slave2_reg1	Slave2_reg0

Table 493. SLV2_SUBADD register description

Slave2_reg[7:0]	Address of register on sensor 2 that has to be read/written according to the r_2 bit value in SLV2_ADD (1Bh).

17.28 SLV2_CONFIG (1Dh)

Third external sensor (sensor 2) configuration register (R/W)

Table 494. SLV2_CONFIG register

0(1)	0(1)	0(1)	0(1)	BATCH_EXT_SENS_2_EN	Slave2_numop2	Slave2_numop1	Slave2_numop0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 495. SLV2_CONFIG register description

BATCH_EXT_SENS_2_EN	Enables FIFO data batching of third slave. Default value: 0
Slave2_numop[2:0]	Number of read operations on sensor 2. Default value: 000

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17.29 SLV3_ADD (1Eh)

I²C slave address of the fourth external sensor (sensor 3) register (R/W)

Table 496. SLV3_ADD register

Slave3_add6	Slave3_add5	Slave3_add4	Slave3_add3	Slave3_add2	Slave3_add1	Slave3_add0	r_3

Table 497. SLV3_ADD register description

Slave3_add[6:0]	I²C slave address of sensor 3 that can be read by the sensor hub.
r_3	Enables read operation on sensor 3. Default value: 0 (0: read operation disabled; 1: read operation enabled)

17.30 SLV3_SUBADD (1Fh)

Address of register on the fourth external sensor (sensor 3) register (R/W)

Table 498. SLV3_SUBADD register

Slave3_reg7	Slave3_reg6	Slave3_reg5	Slave3_reg4	Slave3_reg3	Slave3_reg2	Slave3_reg1	Slave3_reg0

Table 499. SLV3_SUBADD register description

Slave3_reg[7:0]	Address of register on sensor 3 that has to be read according to the r_3 bit value in SLV3_ADD (1Eh).

17.31 SLV3_CONFIG (20h)

Fourth external sensor (sensor 3) configuration register (R/W)

Table 500. SLV3_CONFIG register

0(1)	0(1)	0(1)	0(1)	BATCH_EXT_SENS_3_EN	Slave3_numop2	Slave3_numop1	Slave3_numop0

1. *This bit must be set to 0 for the correct operation of the device.*

Table 501. SLV3_CONFIG register description

BATCH_EXT_SENS_3_EN	Enables FIFO data batching of fourth slave. Default value: 0
Slave3_numop[2:0]	Number of read operations on sensor 3. Default value: 000

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17.32 DATAWRITE_SLV0 (21h)

Data to be written into the slave device register (R/W)

Table 502. DATAWRITE_SLV0 register

Slave0_ dataw7	Slave0_ dataw6	Slave0_ dataw5	Slave0_ dataw4	Slave0_ dataw3	Slave0_ dataw2	Slave0_ dataw1	Slave0_ dataw0

Table 503. DATAWRITE_SLV0 register description

Slave0_dataw[7:0]	Data to be written into the slave 0 device according to the rw_0 bit in register SLV0_ADD (15h). Default value: 00000000

17.33 STATUS_MASTER (22h)

Sensor hub source register (R)

Table 504. STATUS_MASTER register

WR_ONCE _DONE	SLAVE3_ NACK	SLAVE2_ NACK	SLAVE1_ NACK	SLAVE0_ NACK	0	0	SENS_HUB _ENDOP

Table 505. STATUS_MASTER register description

WR_ONCE_DONE	When the bit WRITE_ONCE in MASTER_CONFIG (14h) is configured as 1, this bit is set to 1 when the write operation on slave 0 has been performed and completed. Default value: 0
SLAVE3_NACK	This bit is set to 1 if Not acknowledge occurs on slave 3 communication. Default value: 0
SLAVE2_NACK	This bit is set to 1 if Not acknowledge occurs on slave 2 communication. Default value: 0
SLAVE1_NACK	This bit is set to 1 if Not acknowledge occurs on slave 1 communication. Default value: 0
SLAVE0_NACK	This bit is set to 1 if Not acknowledge occurs on slave 0 communication. Default value: 0
SENS_HUB_ENDOP	Sensor hub communication status. Default value: 0 (0: sensor hub communication not concluded; 1: sensor hub communication concluded)

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18 Soldering information

The LGA package is compliant with the ECOPACK and RoHS standard.
It is qualified for soldering heat resistance according to JEDEC J-STD-020.
For land pattern and soldering recommendations, consult technical note TN0018 available on www.st.com.

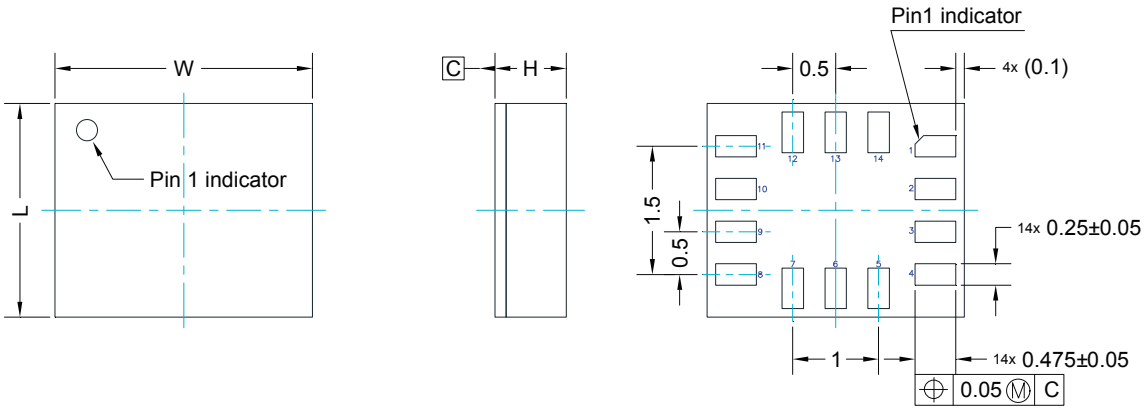
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19 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

19.1 LGA-14L package information

Figure 33. LGA-14L 2.5 x 3.0 x 0.86 mm package outline and mechanical data



Dimensions are in millimeter unless otherwise specified
General tolerance is +/-0.1mm unless otherwise specified

OUTER DIMENSIONS

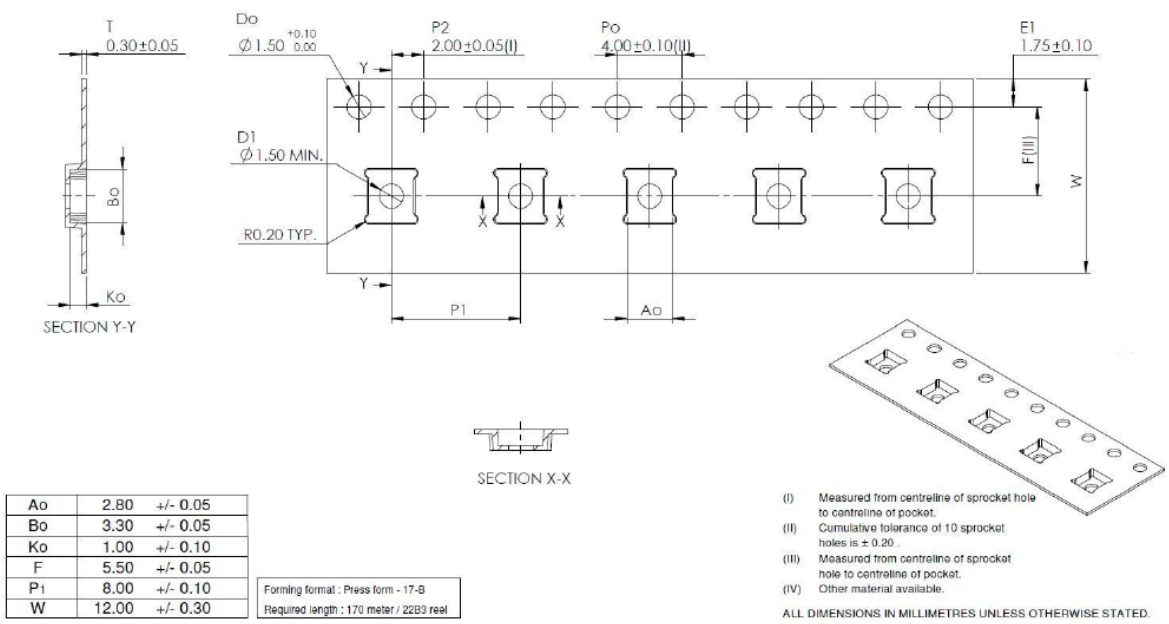
ITEM	DIMENSION [mm]	TOLERANCE [mm]
Length [L]	2.50	±0.1
Width [W]	3.00	±0.1
Height [H]	0.86	MAX

DM00249496_5

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19.2 LGA-14 packing information

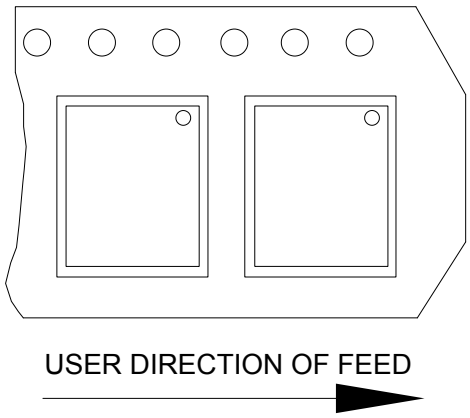
Figure 34. **Carrier tape information for LGA-14 package**



Ao	2.80	+/- 0.05
Bo	3.30	+/- 0.05
Ko	1.00	+/- 0.10
F	5.50	+/- 0.05
P1	8.00	+/- 0.10
W	12.00	+/- 0.30

Forming format : Press form - 17-B
Required length : 170 meter / 22B3 reel

Figure 35. **LGA-14 package orientation in carrier tape**



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Figure 36. **Reel information for carrier tape of LGA-14 package**

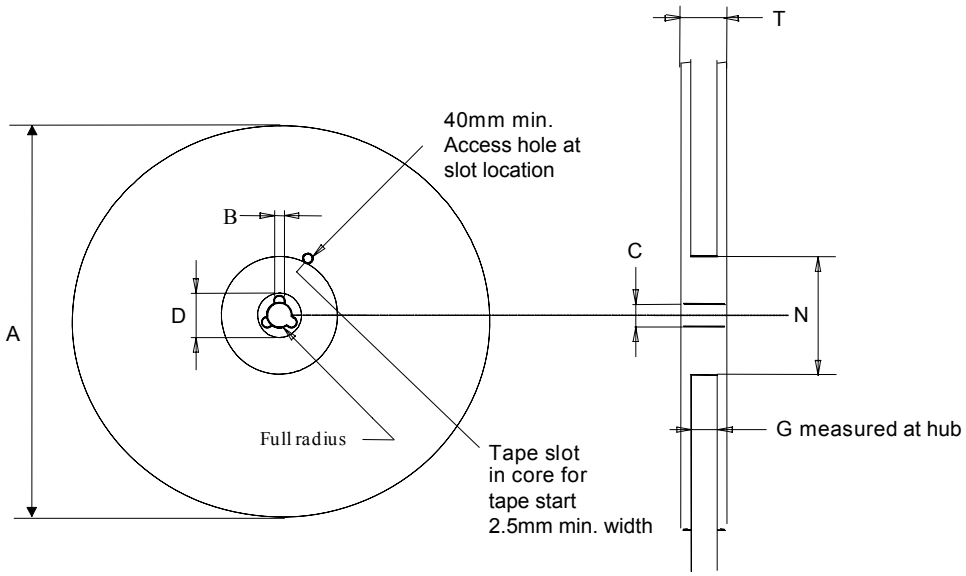


Table 506. **Reel dimensions for carrier tape of LGA-14 package**

Reel dimensions (mm)	
A (max)	330
B (min)	1.5
C	13 ±0.25
D (min)	20.2
N (min)	60
G	12.4 +2/-0
T (max)	18.4

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Revision history

Table 507. **Document revision history**

Date	Revision	Changes
15-Jul-2022	1	Initial release
18-Nov-2022	2	Minor textual updates Added Section 2.8 Sensor fusion low power Updated Section 6.5 High-accuracy ODR mode and added HAODR_CFG (62h) Added Section 6.6 ODR-triggered mode and ODR_TRIG_CFG (06h) Minor update of registers in Section 9 Register description
01-Mar-2023	3	Added Note to Section 3.1 Pin connections
25-May-2023	4	Updated Section 2.1 Pedometer functions: step detector and step counters Updated Note in Section 3.1 Pin connections Updated footnotes of Table 3. Mechanical characteristics Updated Section 6 Functionality Updated Section 6.5 High-accuracy ODR mode Updated registers in Section 9 Register description

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