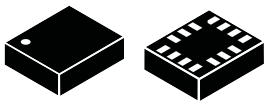
ISM330DHCX

iNEMO inertial module: always-on 3D accelerometer and 3D gyroscope with digital output for industrial applications

Datasheet - production data



LGA-14L
(2.5 x 3 x 0.83 mm) typ.

Features

- 3D accelerometer with selectable full scale: ±2/±4/±8/±16 *g*
- 3D gyroscope with extended selectable full scale: ±125/±250/±500/±1000/±2000/±4000 dps
- Extended temperature range from -40 to +105 °C
- Embedded compensation for high stability over temperature
- SPI/I²C serial interface
- Auxiliary SPI serial interface for data output of gyroscope and accelerometer (OIS and other stabilization applications)
- Six-channel synchronized output
- Sensor hub feature to efficiently collect data from additional external sensors
- Embedded smart FIFO up to 9 kbytes
- Programmable Finite State Machine to process data from accelerometer, gyroscope, and external sensors
- Machine Learning Core
- Smart embedded functions and interrupts: tilt detection, free-fall, wakeup, 6D/4D orientation, click and double-click
- Embedded pedometer, step detector and counter for healthcare applications
- Analog supply voltage: 1.71 V to 3.6 V
- Embedded temperature sensor
- Embedded self-test both for gyroscope and accelerometer
- High shock survivability
- ECOPACK, RoHS and “Green” compliant

Applications

- Industrial IoT and connected devices
- Antennas, platforms, and optical image and lens stabilization
- Robotics, drones and industrial automation
- Navigation systems and telematics
- Vibration monitoring and compensation

Table 1. Device summary

Part number	Temp. range [°C]	Package	Packing
ISM330DHCX	-40 to +105	LGA-14L (2.5x3x0.83 mm)	Tray
ISM330DHCXTR	-40 to +105		Tape & Reel

Product label





Description

The ISM330DHCX is a system-in-package featuring a high-performance 3D digital accelerometer and 3D digital gyroscope tailored for Industry 4.0 applications.

ST’s family of MEMS sensor modules leverages the robust and mature manufacturing processes already used for the production of micromachined accelerometers and gyroscopes.

This is information on a product in full production. www.st.com

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.

In the ISM330DHCX the sensing elements of the accelerometer and of the gyroscope are implemented on the same silicon die, thus guaranteeing superior stability and robustness.

The ISM330DHCX has a full-scale acceleration range of ±2/±4/±8/±16 *g* and a wide angular rate range of ±125/±250/±500/±1000/±2000/±4000 dps that enable its usage in a broad range of applications.

All the design aspects and the calibration of the ISM330DHCX have been optimized to reach superior accuracy, stability, extremely low noise and full data synchronization.

An unmatched set of embedded features (programmable FSM, FIFO, sensor hub, event decoding and interrupts) are enablers for implementing smart and complex sensor nodes which deliver high performance at very low power.

The ISM330DHC is available in a 14-lead plastic land grid array (LGA) package.

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1 Overview

The ISM330DHCX is a system-in-package featuring a high-accuracy and high-performance 3D digital accelerometer and 3D digital gyroscope tailored for Industry 4.0 applications.

All the design aspects and the testing and calibration of the ISM330DHCX have been optimized to reach superior accuracy, stability, extremely low noise and full data synchronization.

The ISM330DHCX has a 3D accelerometer capable of wide bandwidth, ultra-low noise and a selectable full-scale range of ±2/±4/±8/±16 *g*. The 3D gyroscope has an angular rate range of ±125/±250/±500/±1000/±2000/±4000 dps and offers superior stability over temperature and time along with ultra-low noise.

The unique set of embedded features (programmable FSM, 9k smart FIFO, sensor hub, event decoding and interrupts) facilitate the implementation of smart and complex sensor nodes which deliver high performance at very low power.

The ISM330DHCX offers specific support, both for the gyroscope and the accelerometer, to applications requiring closed control loop (like OIS and other stabilization applications). The device, through a dedicated auxiliary SPI interface and a configurable signal processing path, can provide data for the control loop while, at the same time, a second fully independent path can output data for other applications.

Like the entire portfolio of MEMS sensor modules, the ISM330DHCX 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.

In the ISM330DHCX, the sensing elements of the accelerometer and of the gyroscope are implemented on the same silicon die, thus guaranteeing superior stability and robustness.

The ISM330DHCX is available in a small plastic land grid array (LGA) package of 2.5 x 3.0 x 0.83 mm.

2 Embedded low-power features

The ISM330DHCX features the following on-chip functions:

- 9 kbytes 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
  - Wakeup
  - 6D orientation
  - Click and double-click sensing
  - Activity/inactivity recognition
  - Stationary/Motion detection
- Specific IP blocks with negligible power consumption and high-performance:
  - Finite State Machine (FSM) for accelerometer, gyroscope, and external sensors
  - Machine Learning Core (MLC)
  - Significant Motion Detection, tilt, pedometer, step detector and step counters
- Sensor hub
  - Up to 6 total sensors: 2 internal (accelerometer and gyroscope) and 4 external sensors

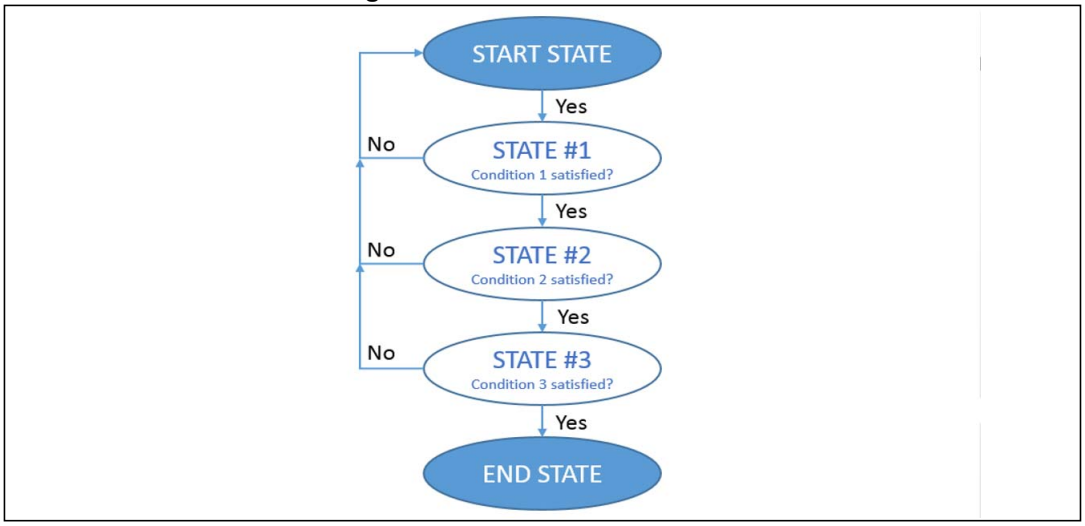
2.1 Finite State Machine

The ISM330DHCX can be configured to generate interrupt signals activated by user-defined motion patterns. To do this, up to 16 embedded finite state machines can be programmed independently for motion detection and decoding.

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. *Figure 1: Generic state machine* shows a generic state machine.

Figure 1. Generic state machine

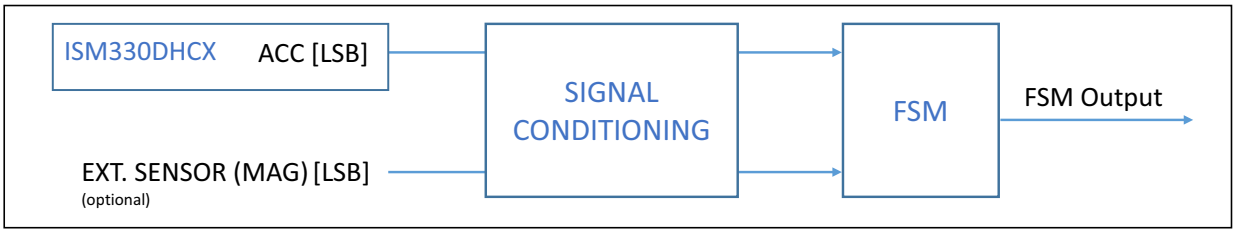


Finite State Machine in the ISM330DHCX

The ISM330DHCX works as a combo accelerometer-gyroscope sensor, generating acceleration and angular rate output data. It is also possible to connect an external sensor (magnetometer) by using the Sensor Hub feature (Mode 2). These data can be used as input of up to 16 programs in the embedded Finite State Machine (*Figure 2: State machine in the ISM330DHCX*).

All 16 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 2. State machine in the ISM330DHCX



2.2 Machine Learning Core

The ISM330DHCX 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.

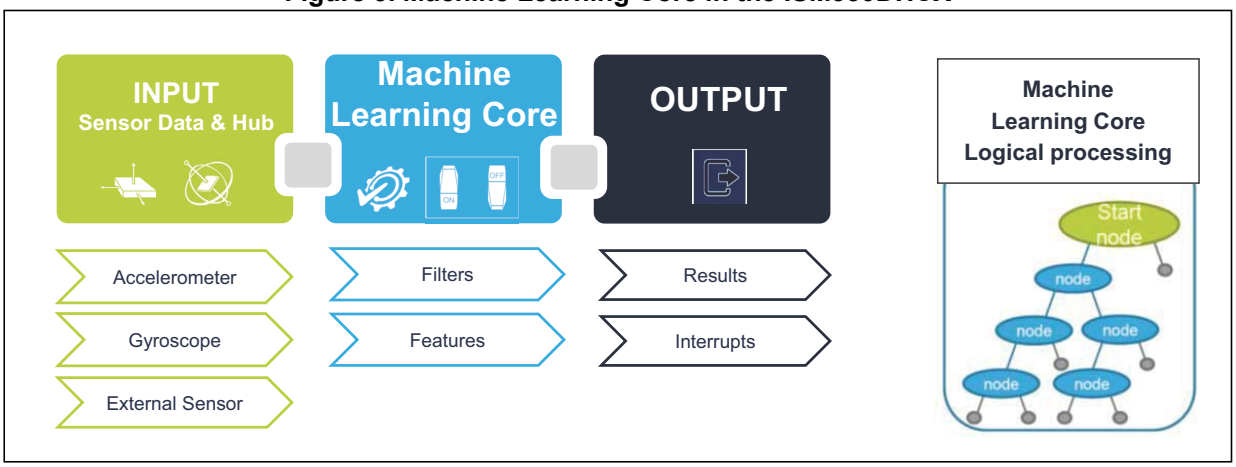
Machine Learning Core logic allows identifying if a data pattern (for example motion, pressure, temperature, magnetic data, etc.) matches a user-defined set of classes. Typical examples of applications could be anomalous vibration, complex movement or condition identification, activity detection, etc.

The ISM330DHCX 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) 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.

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 3. Machine Learning Core in the ISM330DHCX



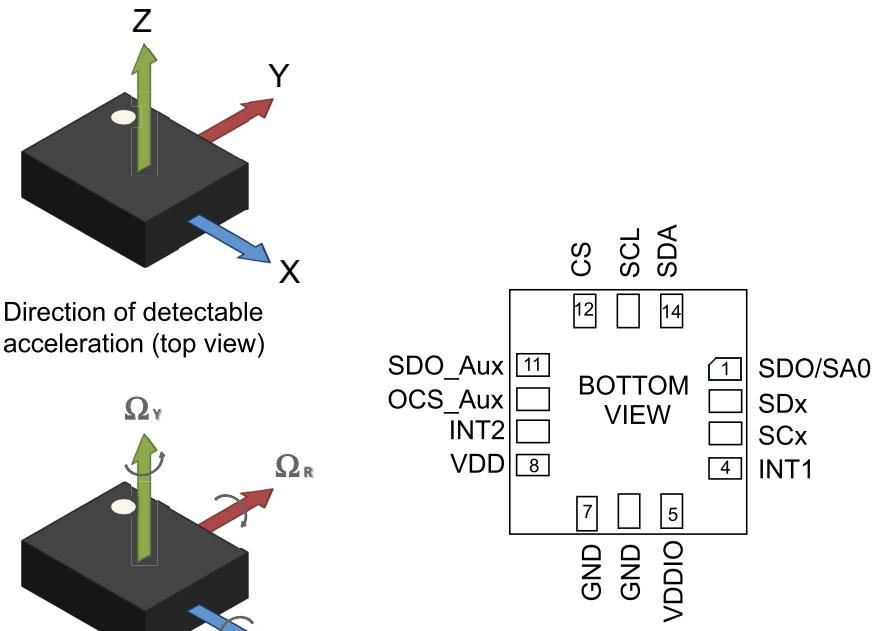
The ISM330DHCX can be configured to run up to 8 flows simultaneously and independently and every flow can generate up to 256 results. The total number of nodes can be up to 512.

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

The ISM330DHCX Machine Learning Core can be configured to generate an interrupt when a change in the result occurs.

3 Pin description

Figure 4. Pin connections

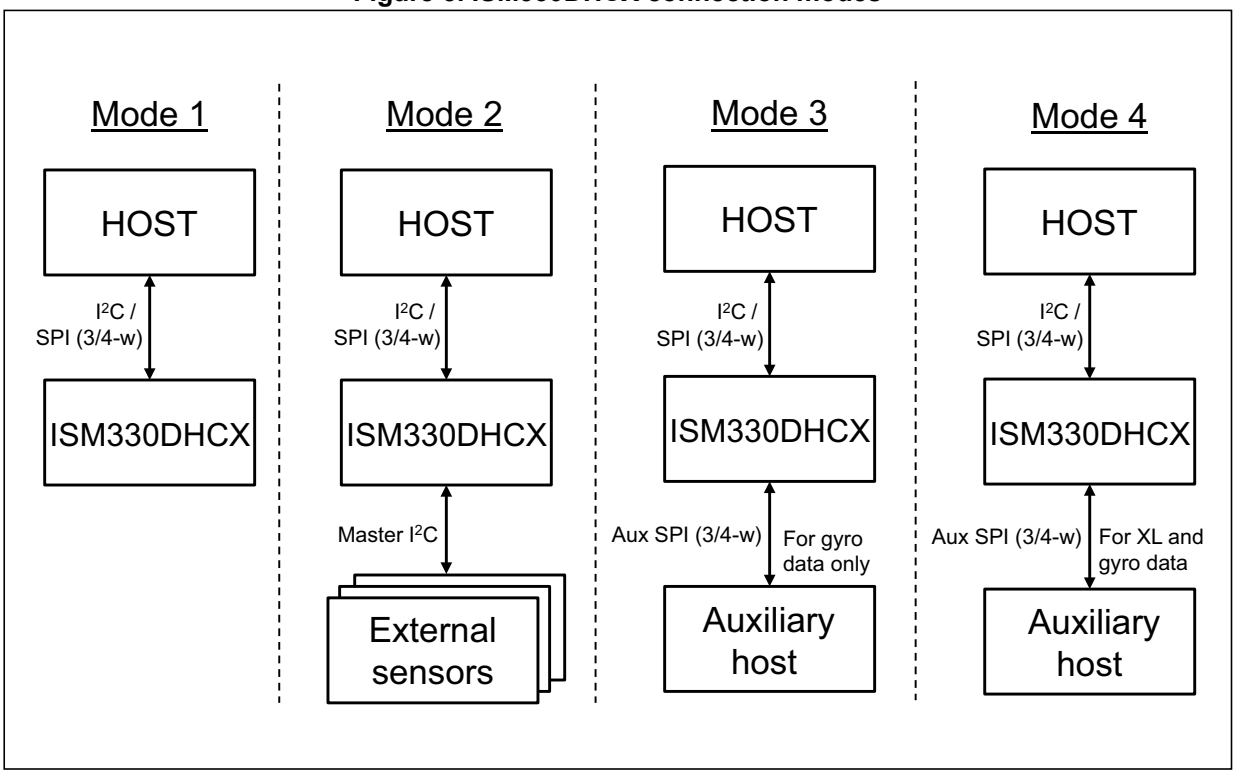


3.1 Pin connections

The ISM330DHCX offers flexibility to connect the pins in order to have four different mode connections and functionalities. In detail:

- **Mode 1**: I²C slave interface or SPI (3- and 4-wire) serial interface is available;
- **Mode 2**: I²C slave interface or SPI (3- and 4-wire) serial interface and I²C interface master for external sensor connections are available;
- **Mode 3:** I²C 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 gyroscope ONLY;
- **Mode 4:** I²C 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.

Figure 5. ISM330DHCX connection modes



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 / Mode 4 function
1	SDO/SA0	SPI 4-wire interface serial data output (SDO) I^2C least significant bit of the device address (SA0)	SPI 4-wire interface serial data output (SDO) I^2C least significant bit of the device address (SA0)	SPI 4-wire interface serial data output (SDO) I^2C least significant bit of the device address (SA0)
2	SDx	Connect to VDDIO or GND	I^2C serial data master (MSDA)	Auxiliary SPI 3/4-wire interface serial data input (SDI) and SPI 3-wire serial data output (SDO)
3	SCx	Connect to VDDIO or GND	I^2C serial clock master (MSCL)	Auxiliary SPI 3/4-wire interface serial port clock (SPC_Aux)
4	INT1	Programmable interrupt in I^2C and SPI		
5	VDDIO(1)	Power supply for I/O pins		
6	GND	0 V supply		
7	GND	0 V supply		
8	VDD(1)	Power supply		
9	INT2	Programmable interrupt 2 (INT2) / Data enable (DEN)	Programmable interrupt 2 (INT2)/ Data enable (DEN)/ I^2C master external synchronization signal (MDRDY)	Programmable interrupt 2 (INT2)/ Data enable (DEN)
10	OCS_Aux	Leave unconnected(2)	Leave unconnected(2)	Auxiliary SPI 3/4-wire interface enable
11	SDO_Aux	Connect to VDD_IO or leave unconnected(2)	Connect to VDD_IO or leave unconnected(2)	Auxiliary SPI 3-wire interface: leave unconnected(2) Auxiliary SPI 4-wire interface: serial data output (SDO_Aux)
12	CS	I^2C/SPI mode selection (1: SPI idle mode / I^2C communication enabled; 0: SPI communication mode / I^2C disabled)	I^2C/SPI mode selection (1: SPI idle mode / I^2C communication enabled; 0: SPI communication mode / I^2C disabled)	I^2C/SPI mode selection (1: SPI idle mode / I^2C communication enabled; 0: SPI communication mode / I^2C disabled)
13	SCL	I^2C serial clock (SCL) SPI serial port clock (SPC)	I^2C serial clock (SCL) SPI serial port clock (SPC)	I^2C serial clock (SCL) SPI serial port clock (SPC)
14	SDA	I^2C serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)	I^2C serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)	I^2C serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)

1. Recommended 100 nF filter capacitor.
2. Leave pin electrically unconnected and soldered to PCB.

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.(1)	Typ.(2)	Max.(1)	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(3)	FS = ±2	-2%	0.061	+2%	mg/LSB
		FS = ±4		0.122		
		FS = ±8		0.244		
		FS = ±16		0.488		
G_So	Angular rate sensitivity(3)	FS = ±125	-2%	4.375	+2%	mdps/LSB
		FS = ±250		8.75		
		FS = ±500		17.50		
		FS = ±1000		35		
		FS = ±2000		70		
		FS = ±4000		140		
LA_SoDr	Linear acceleration sensitivity change vs. temperature(4)	from -40°C to +105°C drift from T = +25°C	-0.01	±0.005	+0.01	%/°C
G_SoDr	Angular rate sensitivity change vs. temperature(4)	from -40°C to +105°C drift from T = +25°C	-0.015	±0.007	+0.015	%/°C
LA_TyOff	Linear acceleration zero-*g* level offset accuracy(5)		-65	±10	+65	mg
G_TyOff	Angular rate zero-rate level(5)		-3	±1	+3	dps
LA_TCOff	Linear acceleration zero-*g* level change vs. temperature(4)		-0.5	±0.1	+0.5	mg/ °C
G_TCOff	Angular rate typical zero-rate level change vs. temperature(4)		-0.015	±0.005	+0.015	dps/°C
LA_Cx	Linear acceleration cross-axis sensitivity	T = 25 °C		±0.5		%

Table 3. Mechanical characteristics (continued)

Symbol	Parameter	Test conditions	Min.(1)	Typ.(2)	Max.(1)	Unit
G_Cx	Angular rate cross-axis sensitivity	T = 25 °C		±1		%
Rn	Rate noise density in high-performance mode(6)			5	8	mdps/√Hz
ARW	Angular random walk	T = 25 °C		0.21	0.34	deg/√h
BI	Bias instability	T = 25 °C		3		deg/h
RnRMS	Gyroscope RMS noise in low-power mode(7)			70		mdps
An	Acceleration noise density in high-performance mode(8)			60	100	µg/√Hz
RMS	Acceleration RMS noise in low-power mode(9)(10)			1.8		mg(RMS)
LA_ODR	Linear acceleration output data rate			1.6(11) 12.5 26 52 104 208 416 833 1666 3332 6667		Hz
G_ODR	Angular rate output data rate			12.5 26 52 104 208 416 833 1666 3332 6667		
LA_F0	Sensor resonant frequency	X,Y-axis Z-axis		2.6 2.17		kHz
G_F0	Sensor resonant frequency			20		kHz
Vst	Linear acceleration self-test output change(12)(13)(14)		90		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		+105	°C

1. Min/Max values are based on characterization results at 3σ on a limited number of samples, not tested in production and not guaranteed.
2. Typical specifications are not guaranteed.

3. Sensitivity values after factory calibration test and trimming.
4. 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.
5. Values after factory calibration test and trimming.
6. Gyroscope rate noise density in high-performance mode is independent of the ODR and FS setting.
7. Gyroscope RMS noise in low-power mode is independent of the ODR and FS setting.
8. Accelerometer noise density in high-performance mode is independent of the ODR and full scale.
9. Accelerometer RMS noise in low-power mode is independent of the ODR.
10. Noise RMS related to BW = ODR/2.
11. This ODR is available when accelerometer is in low-power mode.
12. The sign of the linear acceleration self-test output change is defined by the STx_XL 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 m*g* at ±2 *g* full scale.
14. Accelerometer self-test limits are full-scale independent.
15. The sign of the angular rate self-test output change is defined by the STx_G 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.(1)	Typ.(2)	Max.(1)	Unit
Vdd	Supply voltage		1.71	1.8	3.6	V
Vdd_IO	Power supply for I/O		1.62		3.6	V
IddHP	Gyroscope and accelerometer current consumption in high-performance mode			1.2	1.5	mA
IddNM	Gyroscope and accelerometer current consumption in normal mode	ODR = 208 Hz		0.7		mA
LA_IddHP	Accelerometer current consumption in high-performance mode			360	430	µA
LA_IddLM	Accelerometer current consumption in low-power mode	ODR = 52 Hz ODR = 12.5 Hz ODR = 1.6 Hz		32 11 5.5		µA
IddPD	Gyroscope and accelerometer current consumption during power-down			3		µA
Ton	Turn-on time			35		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 (3)	VDD_IO - 0.2			V
V_{OL}	Low-level output voltage	I_{OL} = 4 mA (3)			0.2	V
Top	Operating temperature range		-40		+105	°C

1. Min/Max values are based on characterization results at 3σ on a limited number of samples, not tested in production and not guaranteed.
2. Typical specifications are not guaranteed.
3. 4 mA is the minimum driving capability, i.e. the minimum DC current that can be sourced/sunk by the digital pad in order to guarantee the correct digital output voltage levels V_{OH} and V_{OL}.

4.3 Temperature sensor characteristics

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

Table 5. Temperature sensor characteristics

Symbol	Parameter	Test condition	Min.(1)	Typ.(2)	Max.(1)	Unit
TODR(3)	Temperature refresh rate			52		Hz
Toff	Temperature offset(4)		-15		+15	°C
TSen	Temperature sensitivity			256		LSB/°C
TST	Temperature stabilization time(5)				500	µs
T_ADC_res	Temperature ADC resolution			16		bit
Top	Operating temperature range		-40		+105	°C

1. Min/Max values are based on characterization results at 3σ on a limited number of samples, not tested in production and not guaranteed.
2. Typical specifications are not guaranteed.
3. When the accelerometer is in Low-Power mode and the gyroscope part is turned off, the TODR value is equal to the accelerometer ODR up to 52 Hz.
4. The output of the temperature sensor is 0 LSB (typ.) at 25 °C.
5. Time from power ON to valid data based on characterization data.

4.4 Communication interface characteristics

4.4.1 SPI - serial peripheral interface

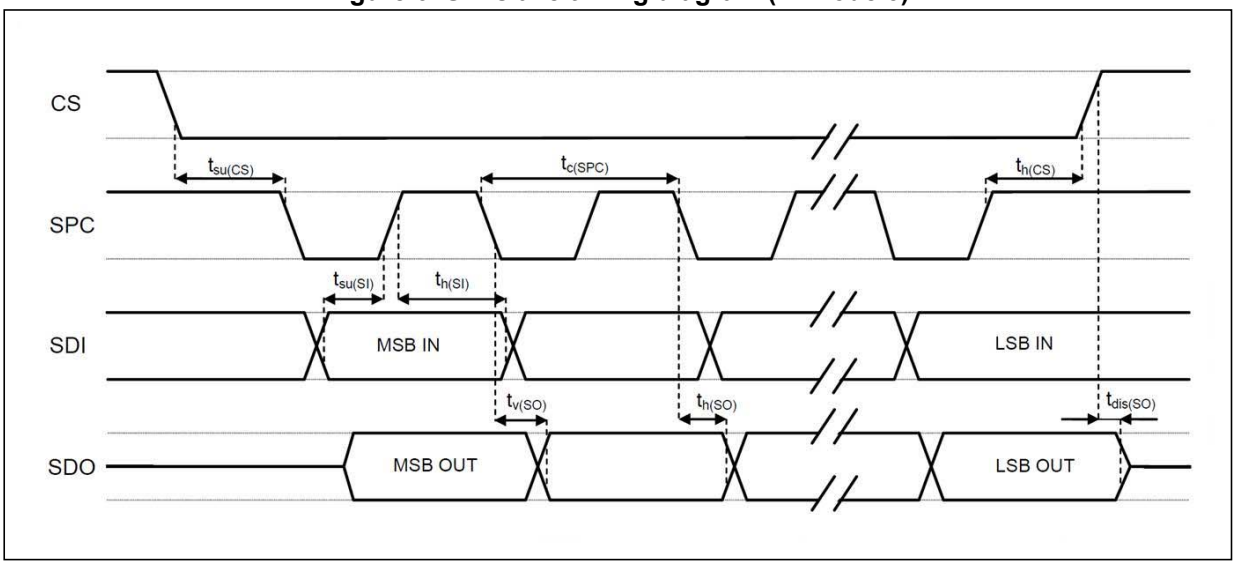
Subject to general operating conditions for Vdd and Top.

Table 6. SPI slave timing values (in mode 3)

Symbol	Parameter	Value(1)		Unit
		Min	Max	
$t_{c(SPC)}$	SPI clock cycle	100		ns
$f_{c(SPC)}$	SPI clock frequency		10	MHz
$t_{su(CS)}$	CS setup time	5		ns
$t_{h(CS)}$	CS hold time	20		
$t_{su(SI)}$	SDI input setup time	5		
$t_{h(SI)}$	SDI input hold time	15		
$t_{v(SO)}$	SDO valid output time		50	
$t_{h(SO)}$	SDO output hold time	5		
$t_{dis(SO)}$	SDO output disable time		50	

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

Figure 6. SPI slave timing diagram (in mode 3)



Note: Measurement points are done at 0.2·Vdd_IO and 0.8·Vdd_IO, for both input and output ports.

4.4.2 I²C - inter-IC control interface

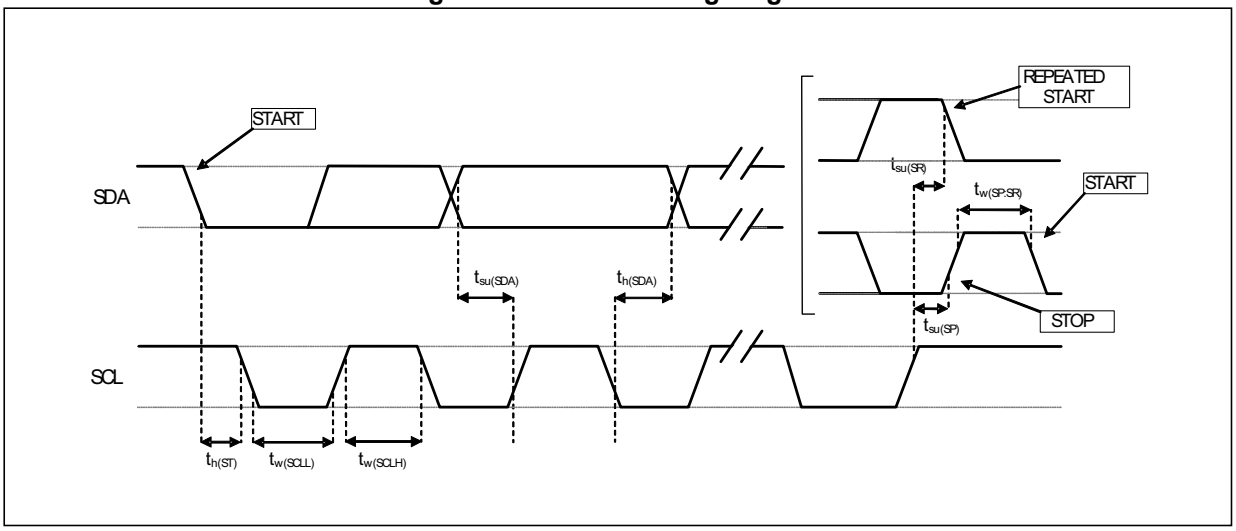
Subject to general operating conditions for Vdd and Top.

Table 7. I²C slave timing values

Symbol	Parameter	I²C standard mode(1)		I²C fast mode (1)		Unit
		Min	Max	Min	Max	
$f_{(SCL)}$	SCL clock frequency	0	100	0	400	kHz
$t_{w(SCLL)}$	SCL clock low time	4.7		1.3		µs
$t_{w(SCLH)}$	SCL clock high time	4.0		0.6		
$t_{su(SDA)}$	SDA setup time	250		100		ns
$t_{h(SDA)}$	SDA data hold time	0	3.45	0	0.9	µs
$t_{h(ST)}$	START condition hold time	4		0.6		µs
$t_{su(SR)}$	Repeated START condition setup time	4.7		0.6		
$t_{su(SP)}$	STOP condition setup time	4		0.6		
$t_{w(SP:SR)}$	Bus free time between STOP and START condition	4.7		1.3		

1. Data based on standard I²C protocol requirement, not tested in production.

Figure 7. I²C slave timing diagram



Note: Measurement points are done at 0.2·Vdd_IO and 0.8·Vdd_IO, for both ports.

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 8. 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.

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 will measure 0 *g* on both the X-axis and Y-axis, whereas the Z-axis will measure 1 *g*. Ideally, the output is in the middle of the dynamic range of the sensor (content of OUT registers 00h, data expressed as 2'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 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*).

5 Digital interfaces

5.1 I²C/SPI interface

The registers embedded inside the ISM330DHCX may be accessed through both the I^2C and SPI serial interfaces. The latter may be SW 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 onto the same pins. To select/exploit the I^2C interface, the CS line must be tied high (i.e connected to Vdd_IO).

Table 9. Serial interface pin description

Pin name	Pin description
CS	SPI enable I^2C/SPI mode selection (1: SPI idle mode / I^2C communication enabled; 0: SPI communication mode / I^2C disabled)
SCL/SPC	I^2C Serial Clock (SCL) SPI Serial Port Clock (SPC)
SDA/SDI/SDO	I^2C Serial Data (SDA) SPI Serial Data Input (SDI) 3-wire Interface Serial Data Output (SDO)
SDO/SA0	SPI Serial Data Output (SDO) I^2C less significant bit of the device address

5.1.1 I²C serial interface

The ISM330DHCX I^2C is a bus slave. The I^2C is employed to write the data to the registers, whose content can also be read back.

The relevant I^2C terminology is provided in the table below.

Table 10. I²C terminology

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

There are two signals associated with the I^2C 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 I^2C interface is implemented with fast mode (400 kHz) I^2C standards as well as with the standard mode.

In order to disable the I^2C block, (I2C_disable) = 1 must be written in *CTRL4_C (13h)*.

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 ISM330DHCX 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 which has been addressed is obliged to generate an acknowledge after each byte of data received.

The I²C embedded inside the ISM330DHCX 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 sub-address (SUB) is transmitted. The increment of the address is configured by the *CTRL3_C (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 sub-address bytes; if the bit is '0' (Write) the master will transmit to the slave with direction unchanged. *Table 11* explains how the SAD+Read/Write bit pattern is composed, listing all the possible configurations.

Table 11. 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 12. Transfer when master is writing one byte to slave

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

Table 13. Transfer when master is writing multiple bytes to slave

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

Table 14. 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 15. 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		

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 receiver can't receive another complete byte of data until it has performed some other function, it can hold the clock line, SCL LOW to force the transmitter into a wait state. Data transfer only continues when the receiver is ready for another byte and releases the data line. If a slave receiver doesn't acknowledge the slave address (i.e. 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.

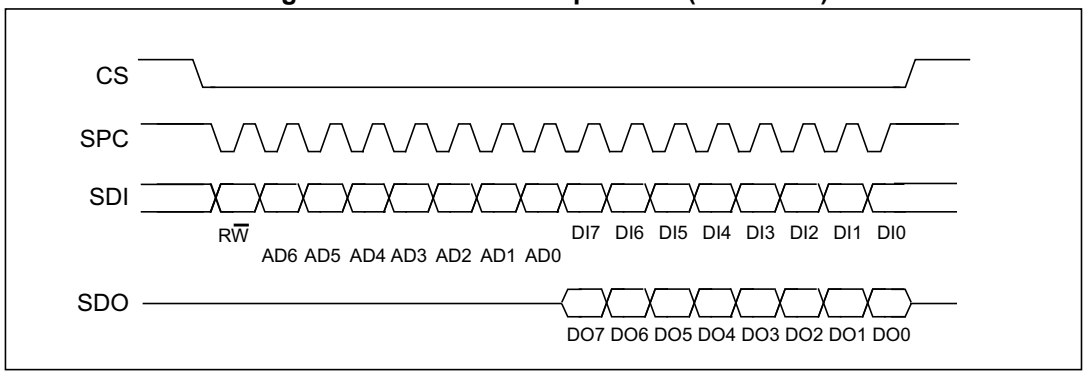
In the presented communication format MAK is Master acknowledge and NMAK is No Master Acknowledge.

5.1.2 SPI bus interface

The ISM330DHCX SPI is a bus slave. The SPI allows writing and reading the registers of the device.

The serial interface communicates to the application using 4 wires: **CS**, **SPC**, **SDI** and **SDO**.

Figure 8. Read and write protocol (in mode 3)



CS is the serial port enable 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: R$\overline{W}$ 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 will drive **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).

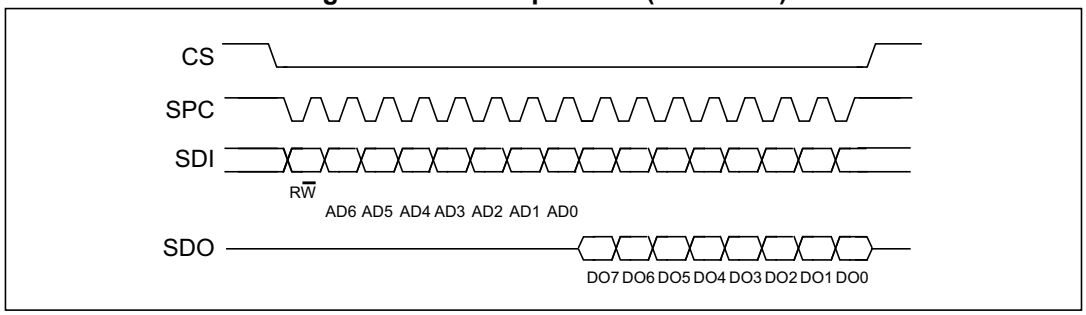
bit 8-15: data DO(7:0) (read mode). This is the data that is read from the device (MSb first).

In multiple read/write commands further blocks of 8 clock periods will be added. When the *CTRL3_C (12h)* (IF_INC) bit is '0', the address used to read/write data remains the same for every block. When the *CTRL3_C (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.

SPI read

Figure 9. 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.

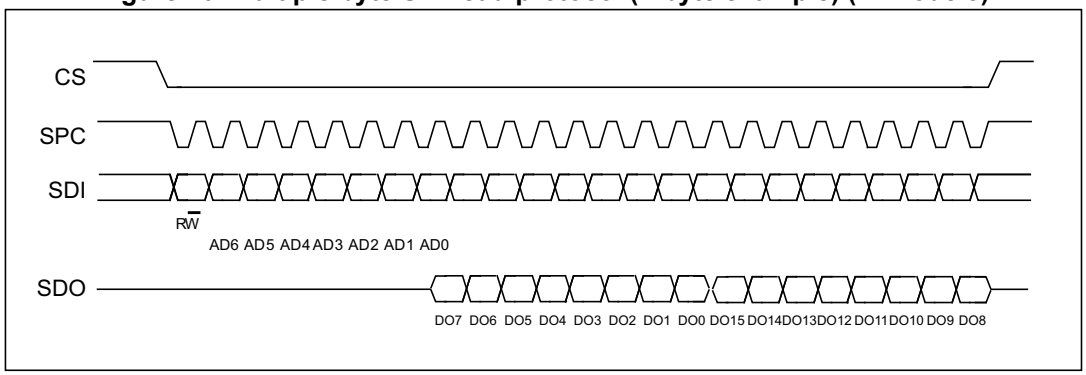
bit 0: READ bit. The value is 1.

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 will be read from the device (MSb first).

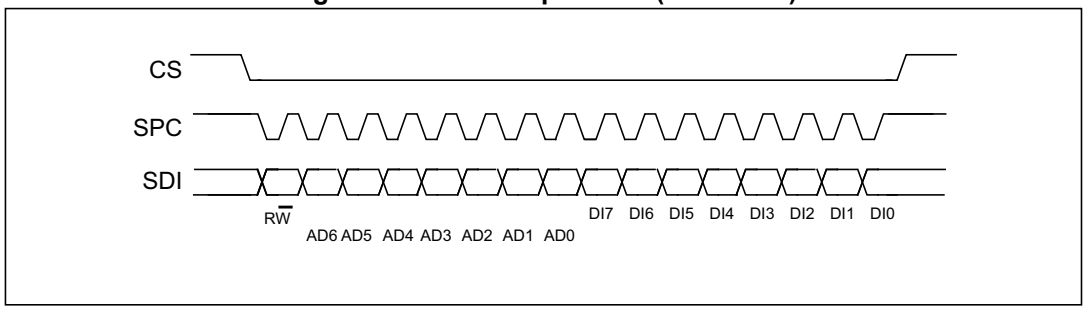
bit 16-...: data DO(...-8). Further data in multiple byte reads.

Figure 10. Multiple byte SPI read protocol (2-byte example) (in mode 3)



SPI write

Figure 11. 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.

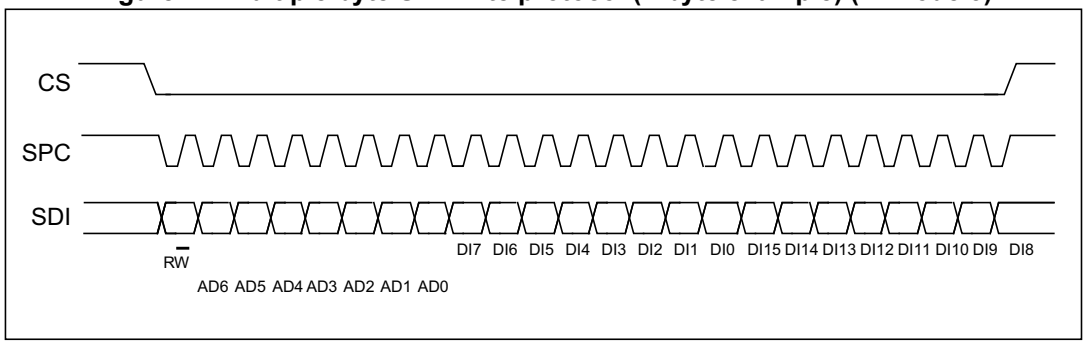
bit 0: WRITE bit. The value is 0.

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.

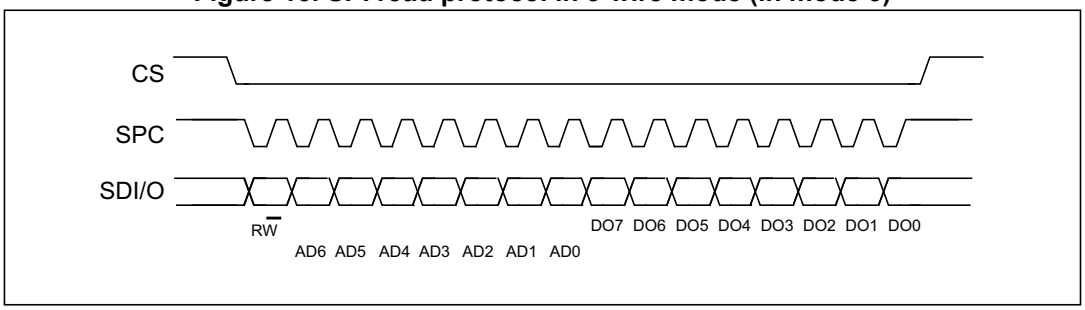
Figure 12. Multiple byte SPI write protocol (2-byte example) (in mode 3)



SPI read in 3-wire mode

A 3-wire mode is entered by setting the *CTRL3_C (12h)* (SIM) bit equal to '1' (SPI serial interface mode selection).

Figure 13. 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.

5.2 Master I²C interface

If the ISM330DHCX is configured in Mode 2, a master I²C line is available. The master serial interface is mapped in the following dedicated pins.

Table 16. Master I²C pin details

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

5.3 Auxiliary SPI interface

If the ISM330DHCX is configured in Mode 3 or Mode 4, the auxiliary SPI is available. The auxiliary SPI interface is mapped to the following dedicated pins.

Table 17. Auxiliary SPI pin details

Pin name	Pin description
OCS_Aux	Auxiliary SPI 3/4-wire enable
SDx	Auxiliary SPI 3/4-wire data input (SDI_Aux) and SPI 3-wire data output (SDO_Aux)
SCx	Auxiliary SPI 3/4-wire interface serial port clock
SDO_Aux	Auxiliary SPI 4-wire data output (SDO_Aux)

When the ISM330DHCX is configured in Mode 3 or Mode 4, the auxiliary SPI can be connected to an auxiliary host. In this configuration, the auxiliary SPI can write only to the dedicated registers *INT_OIS (6Fh)*, *CTRL1_OIS (70h)*, *CTRL2_OIS (71h)*, *CTRL3_OIS (72h)*. All the registers are accessible in Read mode from both the primary interface and auxiliary SPI.

Mode 3 is enabled when the OIS_EN_SPI2 bit in *CTRL1_OIS (70h)* register is set to 1.

Mode 4 is enabled when both the OIS_EN_SPI2 bit and the Mode4_EN bit in *CTRL1_OIS (70h)* register are set to 1.

6 Functionality

6.1 Operating modes

In the ISM330DHCX, 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 ISM330DHCX has three operating modes available:

- only accelerometer active and gyroscope in power-down or sleep mode
- only gyroscope active and accelerometer in power-down
- both accelerometer and gyroscope sensors active with independent ODR

The accelerometer is activated from power-down by writing ODR_XL[3:0] in *CTRL1_XL (10h)* while the gyroscope is activated from power-down by writing ODR_G[3:0] in *CTRL2_G (11h)*. For combo-mode the ODRs are totally independent.

6.2 Gyroscope power modes

In the ISM330DHCX, the gyroscope can be configured in four different operating modes: power-down, low-power, normal mode and high-performance mode. The operating mode selected depends on the value of the G_HM_MODE bit in *CTRL7_G (16h)*. If G_HM_MODE is set to '0', high-performance mode is valid for all ODRs (from 12.5 Hz up to 6.66 kHz).

To enable the low-power and normal mode, the G_HM_MODE bit has to be set to '1'. Low-power mode is available for lower ODRs (12.5, 26, 52 Hz) while normal mode is available for ODRs equal to 104 and 208 Hz.

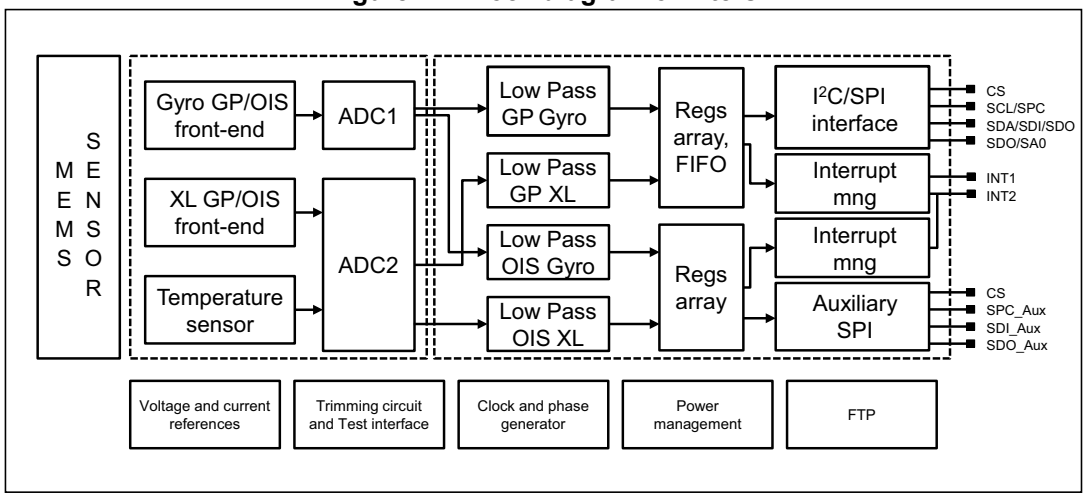
6.3 Accelerometer power modes

In the ISM330DHCX, the accelerometer can be configured in four different operating modes: power-down, low-power, normal mode and high-performance mode. The operating mode selected depends on the value of the XL_HM_MODE bit in *CTRL6_C (15h)*. If XL_HM_MODE is set to '0', high-performance mode is valid for all ODRs (from 12.5 Hz up to 6.66 kHz).

To enable the low-power and normal mode, the XL_HM_MODE bit has to be set to '1'. Low-power mode is available for lower ODRs (1.6, 12.5, 26, 52 Hz) while normal mode is available for ODRs equal to 104 and 208 Hz.

6.4 Block diagram of filters

Figure 14. Block diagram of filters



6.4.1 Block diagrams of the accelerometer filters

In the ISM330DHCX, 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 15. Accelerometer GP chain

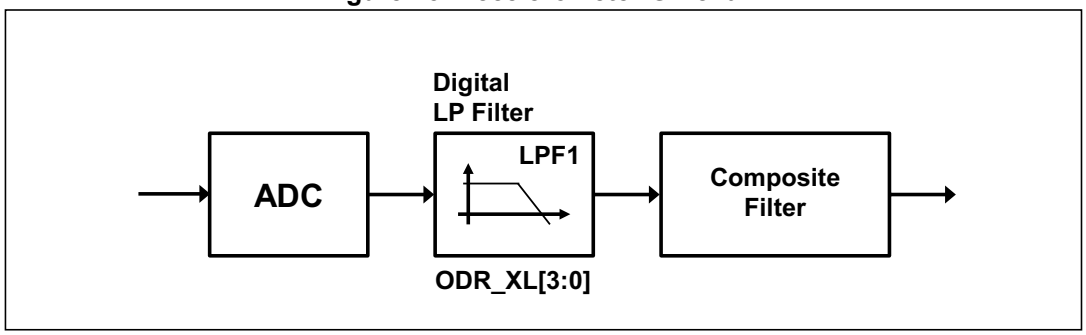
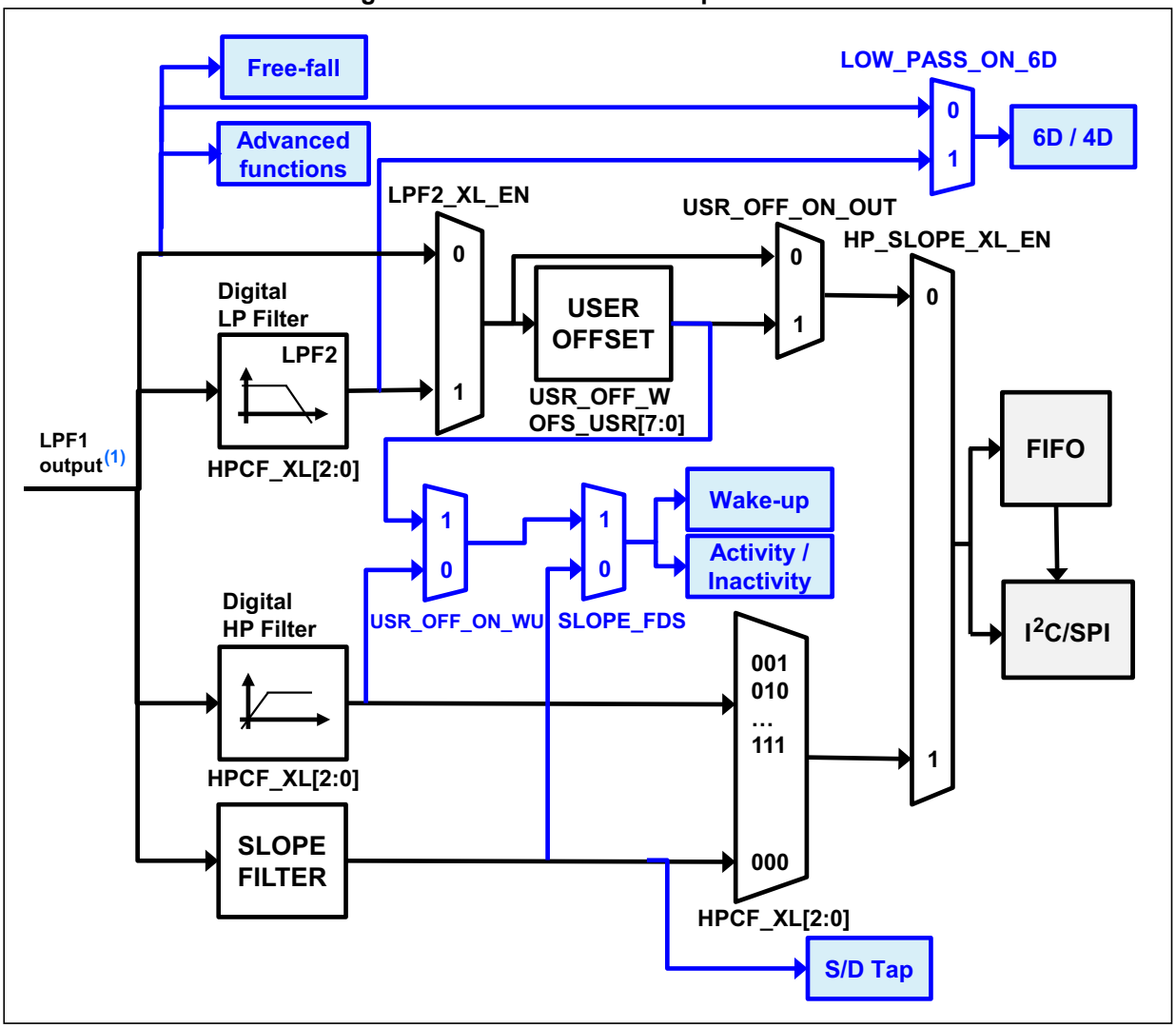


Figure 16. Accelerometer composite filter

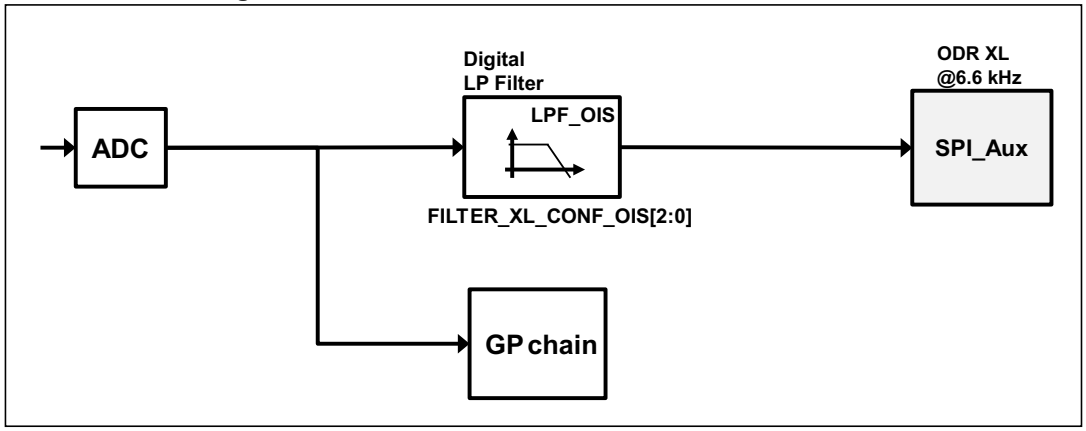


1. The cutoff value of the LPF1 output is ODR/2 when the accelerometer is in high-performance mode and ODR up to 833 Hz. This value is equal to 780 Hz when the accelerometer is in low-power or normal mode.

Note: Advanced functions, relevant for healthcare applications, include pedometer, step detector and step counter, significant motion detection, tilt function, Finite State Machine and Machine Learning Core.

The accelerometer filtering chain when Mode 4 is enabled is illustrated in the following figure.

Figure 17. Accelerometer chain with Mode 4 enabled



Note: Mode 4 is enabled when Mode4_EN = 1 and OIS_EN_SPI2 = 1 in CTRL1_OIS (70h).

The configuration of the accelerometer GP chain is not affected by enabling Mode 4.

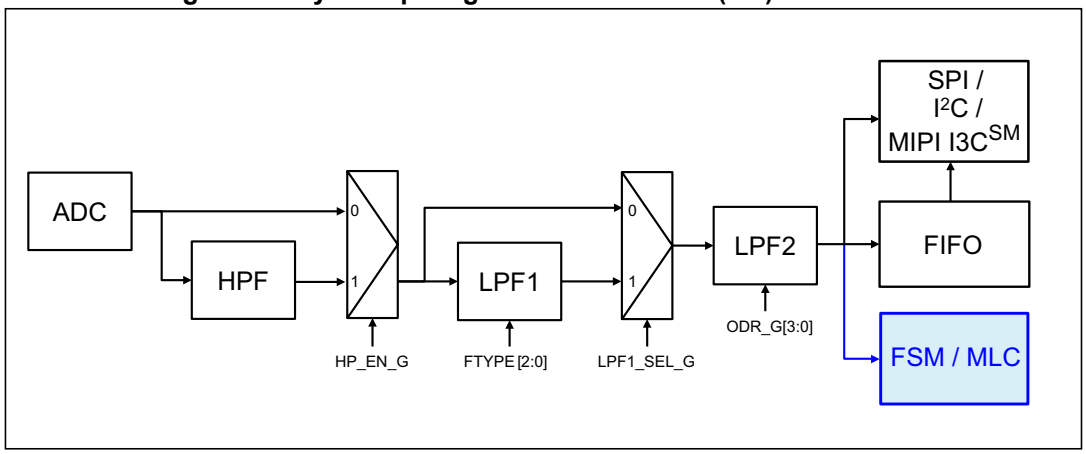
Accelerometer output values are in registers *OUTX_L_A (28h) and OUTX_H_A (29h)* through *OUTZ_L_A (2Ch) and OUTZ_H_A (2Dh)* and ODR at 6.66 kHz.

6.4.2 Block diagrams of the gyroscope filters

In the ISM330DHCX, the gyroscope filtering chain depends on the mode configuration:

- Mode 1 (for General Purpose (GP) functionality through primary interface) and Mode 2

Figure 18. Gyroscope digital chain - Mode 1 (GP) and Mode 2



In this configuration, the gyroscope ODR is selectable from 12.5 Hz up to 6.66 kHz. A low-pass filter (LPF1) is available if the auxiliary SPI is disabled, for more details about the filter characteristics see *Table 59: Gyroscope LPF1 bandwidth selection*.

The digital LPF2 filter cannot be configured by the user and its cutoff frequency depends on the selected gyroscope ODR, as indicated in the following table.

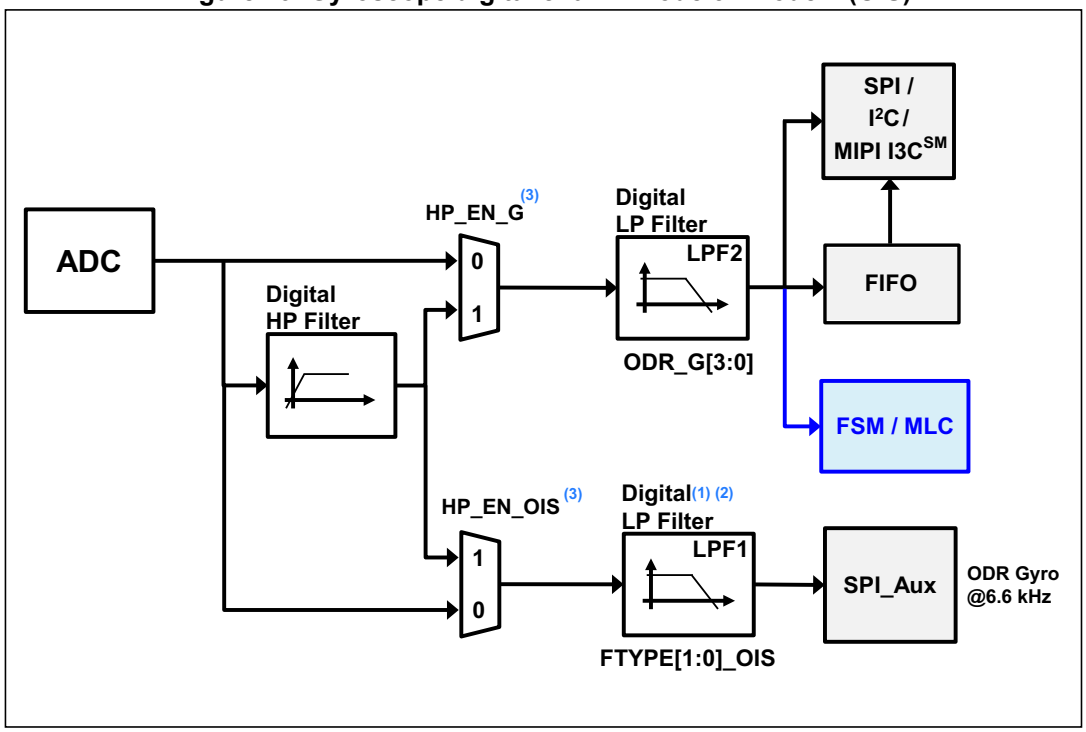
Table 18. Gyroscope LPF2 bandwidth selection

Gyroscope ODR [Hz]	LPF2 cutoff [Hz]
12.5	4.3
26	8.3
52	16.7
104	33
208	67
417	133
833	267
1667	539
3333	1137
6667	3333

Data can be acquired from the output registers and FIFO over the primary I²C/SPI interface.

- Mode 3 / Mode 4 (for OIS functionality)

Figure 19. Gyroscope digital chain - Mode 3 / Mode 4 (OIS)



1. When Mode3/4 is enabled, the LPF1 filter is not available in the gyroscope GP chain.
2. It is recommended to avoid using the LPF1 filter in Mode1/2 when Mode3/4 is intended to be used.
3. HP_EN_OIS can be used to select the HPF on the OIS path only if the HPF is not used in the GP chain. If both the HP_EN_G bit and HP_EN_OIS bit are set to 1, the HP filter is applied to the GP chain only.

The auxiliary interface needs to be enabled in *CTRL1_OIS (70h)*.

In Mode 3/4 configuration, there are two paths:

- the chain for General Purpose (GP) where the ODR is selectable from 12.5 Hz up to 6.66 kHz
- the chain for OIS where the ODR is at 6.66 kHz and the LPF1 is available. The LPF1 configuration depends on the setting of the FTYPE_[1:0] _OIS bit in register *CTRL2_OIS (71h)*; for more details about the filter characteristics see *Table 150: Gyroscope OIS chain digital LPF1 filter bandwidth selection*. Gyroscope output values are in registers 22h to 27h with the selected full scale (FS[1:0]_G_OIS bit in *CTRL1_OIS (70h)*).

6.5 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 ISM330DHCX embeds 3 kbytes of data in FIFO (up to 9 kbytes with the compression feature enabled) to store the following data::

- Gyroscope
- Accelerometer
- External sensors (up to 4)
- Step counter
- Timestamp
- Temperature

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 batching 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 (Batching 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 9 kbyte 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 in *FIFO_CTRL1 (07h)* and *FIFO_CTRL2 (08h)* using the WTM[8:0] bits. To monitor the FIFO status, dedicated registers (*FIFO_STATUS1 (3Ah)*, *FIFO_STATUS2 (3Bh)*) 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 six different modes:

- Bypass mode
- FIFO mode
- Continuous mode
- Continuous-to-FIFO 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.

6.5.1 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.

6.5.2 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 9 kbytes of data (with compression enabled) but the depth of the FIFO can be resized by setting the WTM [8:0] bits in *FIFO_CTRL1 (07h)* and *FIFO_CTRL2 (08h)*. If the STOP_ON_WTM bit in *FIFO_CTRL2 (08h)* is set to '1', FIFO depth is limited up to the WTM [8:0] bits in *FIFO_CTRL1 (07h)* and *FIFO_CTRL2 (08h)*.

6.5.3 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 (3Bh)*(FIFO_WTM_IA) is asserted when the number of unread samples in FIFO is greater than or equal to *FIFO_CTRL1 (07h)* and *FIFO_CTRL2 (08h)*(WTM [8:0]).

It is possible to route the FIFO_WTM_IA flag to *FIFO_CTRL2 (08h)* 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 (3Bh)* 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 (3Ah)* and *FIFO_STATUS2 (3Bh)*(DIFF_FIFO_[9:0]).

6.5.4 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.

6.5.5 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

6.5.6 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

6.5.7 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_[9:0] field in the *FIFO_STATUS1 (3Ah)* and *FIFO_STATUS2 (3Bh)* 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 (3Bh)* alerts that the counter reaches a selectable threshold (CNT_BDR_TH_[10:0] 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 bit 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)*).

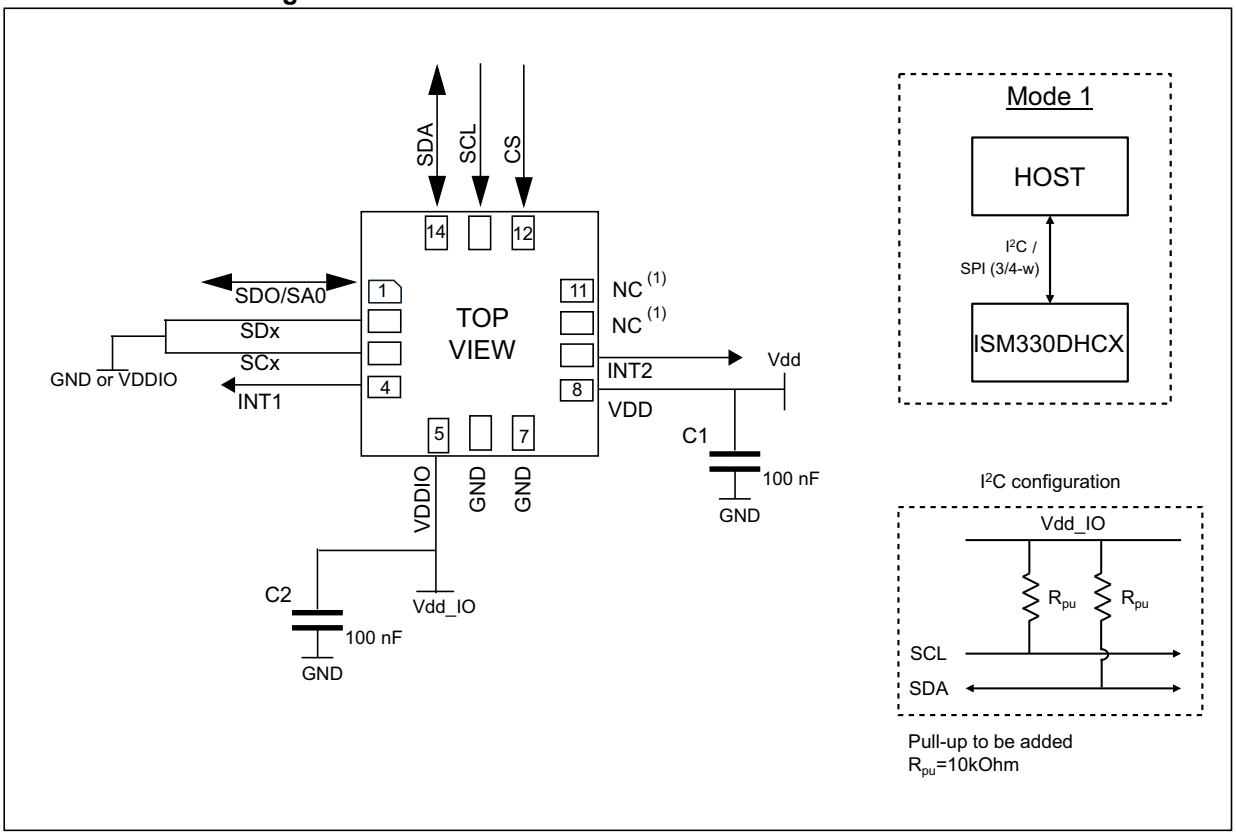
In order to maximize the amount of accelerometer and gyroscope data in FIFO, the user can enable the compression algorithm by setting to 1 both the FIFO_COMPR_EN bit in *EMB_FUNC_EN_B (05h)* (embedded functions registers bank) and the FIFO_COMPR_RT_EN bit in *FIFO_CTRL2 (08h)*. When compression is enabled,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

7 Application hints

7.1 ISM330DHCX electrical connections in Mode 1

Figure 20. ISM330DHCX electrical connections in Mode 1



1. Leave pin electrically unconnected and soldered to PCB.

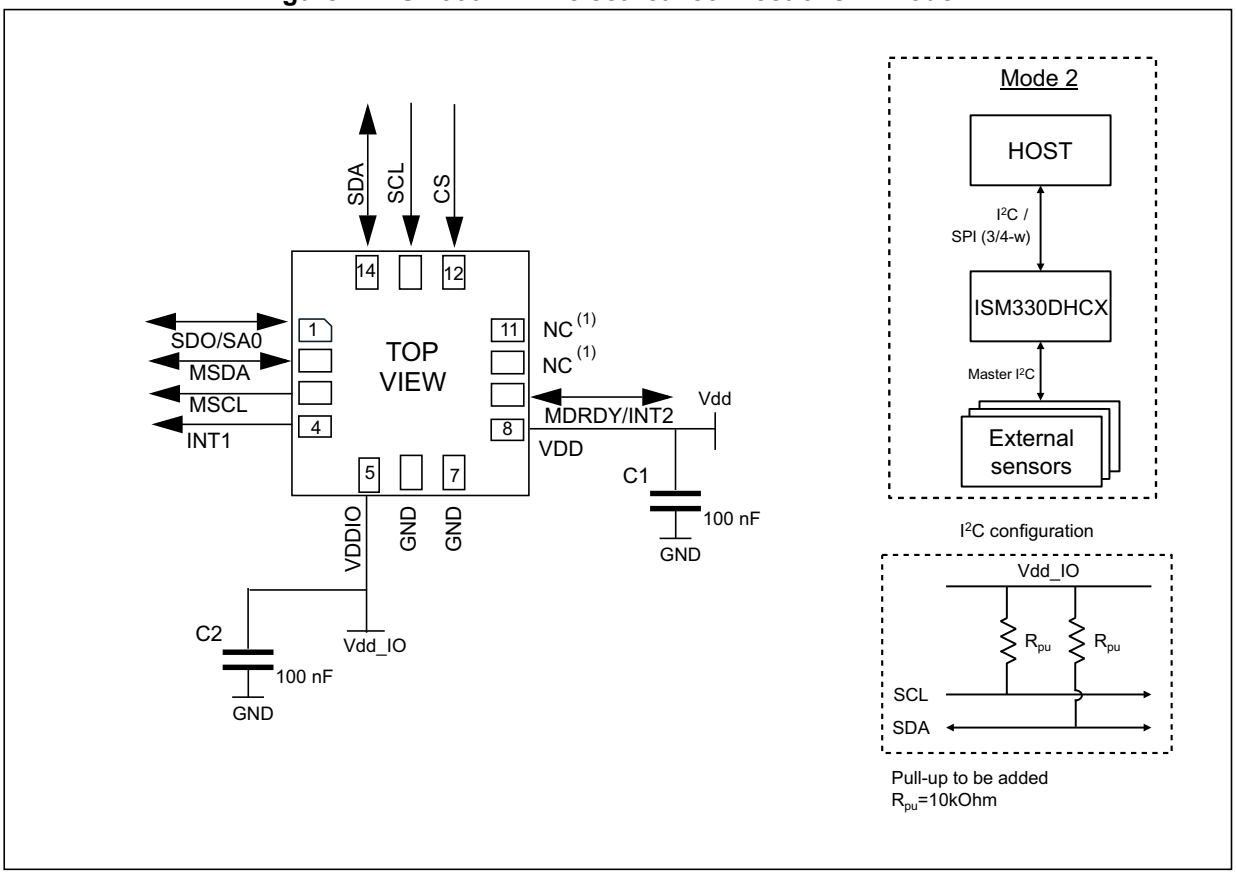
The device core is supplied through the Vdd line. Power supply decoupling capacitors (C1, C2 = 100 *nF* ceramic) should be placed as near as possible to the supply pin of the device (common design practice).

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

7.2 ISM330DHCX electrical connections in Mode 2

Figure 21. ISM330DHCX electrical connections in Mode 2



1. Leave pin electrically unconnected and soldered to PCB.

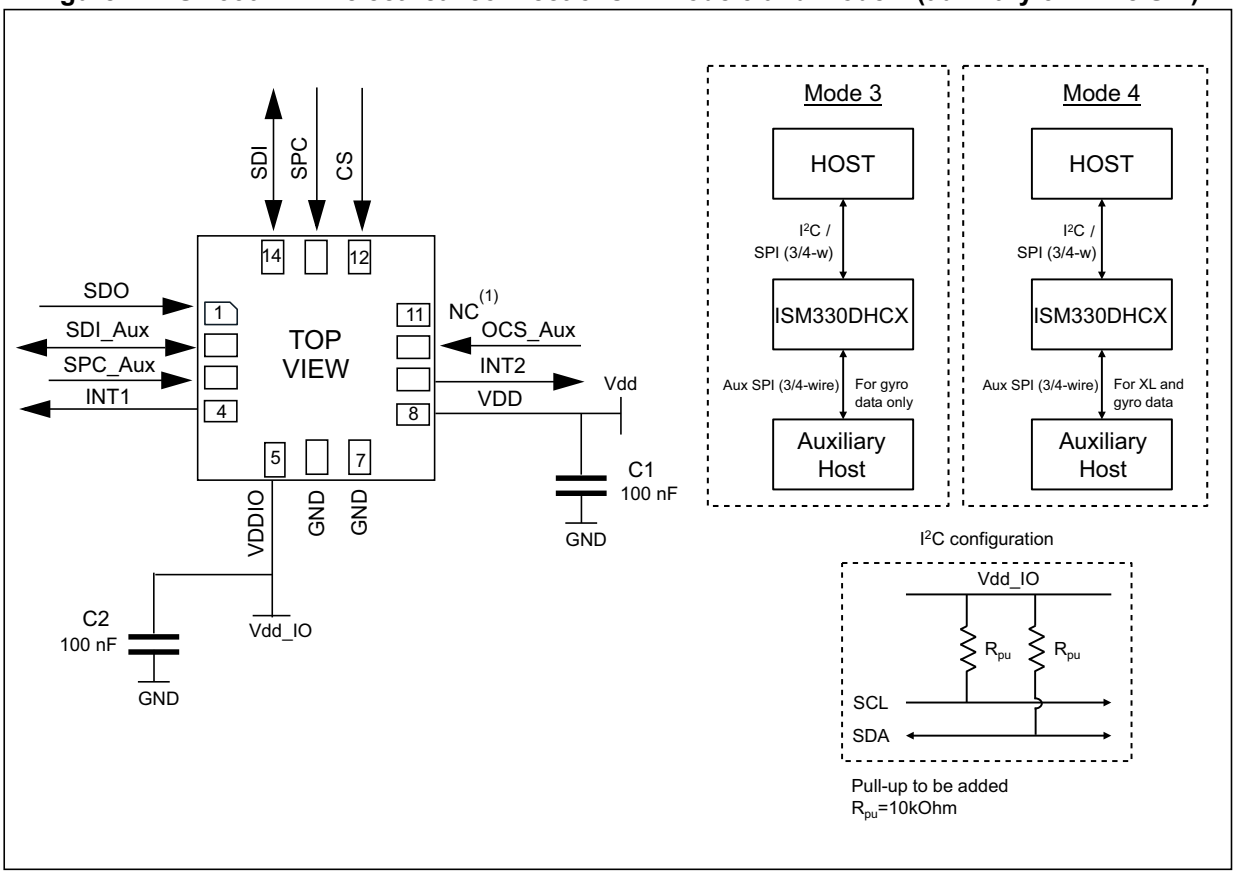
The device core is supplied through the Vdd line. Power supply decoupling capacitors (C1, C2 = 100 *nF* ceramic) should be placed as near as possible to the supply pin of the device (common design practice).

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

7.3 ISM330DHCX electrical connections in Mode 3 and Mode 4

Figure 22. ISM330DHCX electrical connections in Mode 3 and Mode 4 (auxiliary 3/4-wire SPI)



1. Leave pin electrically unconnected and soldered to PCB.

Note: When Mode 3 and 4 are used, the pull-up on pins 10 and 11 can be disabled (refer to Table 19: Internal pin status). To avoid leakage current, it is recommended to add pull-up resistors on the SPI lines unless the SPI master can be left on while 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 I²C/SPI primary interface.

Measured acceleration/angular rate data is selectable and accessible through the I²C/SPI 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 I²C/SPI interface.

Table 19. Internal pin status

pin #	Name	Mode 1 function	Mode 2 function	Mode 3 / Mode 4 function	Pin status Mode 1	Pin status Mode 2	Pin status Mode 3/4[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 reg 02h.	Default: input without pull-up. Pull-up is enabled if bit SDO_PU_EN = 1 in reg 02h.	Default: Input without pull-up. Pull-up is enabled if bit SDO_PU_EN = 1 in reg 02h.
	SA0	I^2C least significant bit of the device address (SA0)	I^2C least significant bit of the device address (SA0)	I^2C least significant bit of the device address (SA0)			
2	SDx	Connect to VDDIO or GND	I^2C serial data master (MSDA)	Auxiliary SPI 3/4-wire interface serial data input (SDI) and SPI 3-wire serial data output (SDO)	Default: input without pull-up. Pull-up is enabled if bit SHUB_PU_EN = 1 in reg 14h in sensor hub registers (see Note to enable pull-up).	Default: input without pull-up. Pull-up is enabled if bit SHUB_PU_EN = 1 in reg 14h in sensor hub registers (see Note to enable pull-up).	Default: input without pull-up. Pull-up is enabled if bit SHUB_PU_EN = 1 in reg 14h in sensor hub registers (see Note to enable pull-up).
3	SCx	Connect to VDDIO or GND	I^2C 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 reg 14h in sensor hub registers (see Note to enable pull-up).	Default: input without pull-up. Pull-up is enabled if bit SHUB_PU_EN = 1 in reg 14h in sensor hub registers (see Note to enable pull-up).	Default: input without pull-up. Pull-up is enabled if bit SHUB_PU_EN = 1 in reg 14h in sensor hub registers (see Note to enable pull-up)
4	INT1	Programmable interrupt 1	Programmable interrupt 1	Programmable interrupt 1	Default: input with pull-down[2]	Default: input with pull-down[2]	Default: input with pull-down[2]
5	VDDIO	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			

Table 19. Internal pin status (continued)

pin #	Name	Mode 1 function	Mode 2 function	Mode 3 / Mode 4 function	Pin status Mode 1	Pin status Mode 2	Pin status Mode 3/4(1)
9	INT2	Programmable interrupt 2 (INT2) / Data enabled (DEN)	Programmable interrupt 2 (INT2) / Data enabled (DEN) / I^2C 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	Leave unconnected	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 reg 02h.	Default: input with pull-up. Pull-up is disabled if bit OIS_PU_DIS = 1 in reg 02h.	Default: input without pull-up (regardless of the value of bit OIS_PU_DIS in reg 02h.)
11	SDO_Aux	Connect to VDDIO or leave unconnected	Connect to VDDIO 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 reg 02h.	Default: input with pull-up. Pull-up is disabled if bit OIS_PU_DIS = 1 in reg 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 reg 02h.
12	CS	I^2C/SPI mode selection (1:SPI idle mode / I^2C communication enabled; 0: SPI communication mode / I^2C disabled)	I^2C/SPI mode selection (1:SPI idle mode / I^2C communication enabled; 0: SPI communication mode / I^2C disabled)	I^2C/SPI mode selection (1:SPI idle mode / I^2C communication enabled; 0: SPI communication mode / I^2C disabled)	Default: input with pull-up. Pull-up is disabled if bit I2C_disable = 1 in reg 13h.	Default: input with pull-up. Pull-up is disabled if bit I2C_disable = 1 in reg 13h.	Default: input with pull-up. Pull-up is disabled if bit I2C_disable = 1 in reg 13h.

Table 19. Internal pin status (continued)

pin #	Name	Mode 1 function	Mode 2 function	Mode 3 / Mode 4 function	Pin status Mode 1	Pin status Mode 2	Pin status Mode 3/4(1)
13	SCL	I²C serial clock (SCL) / SPI serial port clock (SPC)	I²C serial clock (SCL) / SPI serial port clock (SPC)	I²C 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 serial data (SDA) / SPI serial data input (SDI) / 3-wire interface serial data output (SDO)	I²C serial data (SDA) / SPI serial data input (SDI) / 3-wire interface serial data output (SDO)	I²C serial data (SDA) / SPI serial data input (SDI) / 3-wire interface serial data output (SDO)	Default: input without pull-up	Default: input without pull-up	Default: input without pull-up

1. Mode 3 is enabled when the OIS_EN_SPI2 bit in the *CTRL1_OIS (70h)* register is set to 1. Mode 4 is enabled when both the OIS_EN_SPI2 bit and the Mode4_EN bit in *CTRL1_OIS (70h)* register are set to 1.
2. INT1 must be set to '0' or left unconnected during power-on if the I²C/SPI interfaces are used.

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

Note: The procedure to enable the pull-up on pins 2 and 3 is as follows:

*1. From the primary I²C/*SPI *interface: write 40h in register at address 01h (enable access to the sensor hub registers)*

*2. From the primary I²C/*SPI *interface: write 08h in register at address 14h (enable the pull-up on pins 2 and 3)*

*3. From the primary I²C/*SPI *interface: write 00h in register at address 01h (disable access to the sensor hub registers)*

8 Register mapping

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

Table 20. Registers address map

Name	Type	Register address		Default	Comment
		Hex	Binary		
FUNC_CFG_ACCESS	RW	01	00000001	00000000	
PIN_CTRL	RW	02	00000010	00111111	
RESERVED	-	03-06			
FIFO_CTRL1	RW	07	00000111	00000000	
FIFO_CTRL2	RW	08	00001000	00000000	
FIFO_CTRL3	RW	09	00001001	00000000	
FIFO_CTRL4	RW	0A	00001010	00000000	
COUNTER_BDR_REG1	RW	0B	00001011	00000000	
COUNTER_BDR_REG2	RW	0C	00001100	00000000	
INT1_CTRL	RW	0D	00001101	00000000	
INT2_CTRL	RW	0E	00001110	00000000	
WHO_AM_I	R	0F	00001111	01101011	R (SPI2)
CTRL1_XL	RW	10	00010000	00000000	R (SPI2)
CTRL2_G	RW	11	00010001	00000000	R (SPI2)
CTRL3_C	RW	12	00010010	00000100	R (SPI2)
CTRL4_C	RW	13	00010011	00000000	R (SPI2)
CTRL5_C	RW	14	00010100	00000000	R (SPI2)
CTRL6_C	RW	15	00010101	00000000	R (SPI2)
CTRL7_G	RW	16	00010110	00000000	R (SPI2)
CTRL8_XL	RW	17	0001 0111	00000000	R (SPI2)
CTRL9_XL	RW	18	00011000	11100000	R (SPI2)
CTRL10_C	RW	19	00011001	00000000	R (SPI2)
ALL_INT_SRC	R	1A	00011010	output	
WAKE_UP_SRC	R	1B	00011011	output	
TAP_SRC	R	1C	00011100	output	
D6D_SRC	R	1D	00011101	output	
STATUS_REG(1)/ STATUS_SPIAux(2)	R	1E	00011110	output	
RESERVED	-	1F	00011111		
OUT_TEMP_L	R	20	00100000	output	

Table 20. Registers address map (continued)

Name	Type	Register address		Default	Comment
		Hex	Binary		
OUT_TEMP_H	R	21	00100001	output	
OUTX_L_G	R	22	00100010	output	
OUTX_H_G	R	23	00100011	output	
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	
RESERVED	-	2E-34			
EMB_FUNC_STATUS_ MAINPAGE	R	35	00110101	output	
FSM_STATUS_A_ MAINPAGE	R	36	00110110	output	
FSM_STATUS_B_ MAINPAGE	R	37	00110111	output	
MLC_STATUS_MAINPAGE	R	38	00111000	output	
STATUS_MASTER_ MAINPAGE	R	39	00111001	output	
FIFO_STATUS1	R	3A	00111010	output	
FIFO_STATUS2	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)
RESERVED	-	44-55			
TAP_CFG0	RW	56	01010110	00000000	
TAP_CFG1	RW	57	01010111	00000000	
TAP_CFG2	RW	58	01011000	00000000	
TAP_THS_6D	RW	59	01011001	00000000	
INT_DUR2	RW	5A	01011010	00000000	

Table 20. Registers address map (continued)

Name	Type	Register address		Default	Comment
		Hex	Binary		
WAKE_UP_THS	RW	5B	01011011	00000000	
WAKE_UP_DUR	RW	5C	01011100	00000000	
FREE_FALL	RW	5D	01011101	00000000	
MD1_CFG	RW	5E	01011110	00000000	
MD2_CFG	RW	5F	01011111	00000000	
RESERVED	-	60-62			
INTERNAL_FREQ_FINE	R	63	01100011	output	
RESERVED	-	64-6E			
INT_OIS	R	6F	01101111	00000000	RW (SPI2)
CTRL1_OIS	R	70	01110000	00000000	RW (SPI2)
CTRL2_OIS	R	71	01110001	00000000	RW (SPI2)
CTRL3_OIS	R	72	01110010	00000000	RW (SPI2)
X_OFS_USR	RW	73	01110011	00000000	
Y_OFS_USR	RW	74	01110100	00000000	
Z_OFS_USR	RW	75	01110101	00000000	
RESERVED	-	76-77			
FIFO_DATA_OUT_TAG	R	78	01111000	output	
FIFO_DATA_OUT_X_L	R	79	01111001	output	
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_X_H	R	7E	01111110	output	

1. This register status is read using the primary interface for user interface data.
2. This register status is read using the auxiliary SPI for OIS data.

9 Register description

The device contains a set of registers which are used to control its behavior and to retrieve linear acceleration, angular rate and temperature 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 21. FUNC_CFG_ACCESS register

FUNC_CFG_ACCESS	SHUB_REG_ACCESS	0(1)	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 22. FUNC_CFG_ACCESS register description

FUNC_CFG_ACCESS	Enable access to the embedded functions configuration registers. Default value: 0(1)
SHUB_REG_ACCESS	Enable access to the sensor hub (I^2C master) registers. Default value: 0(2)

1. Details concerning the embedded functions configuration registers are available in *Section 10: Embedded functions register mapping* and *Section 11: Embedded functions register description*.
2. Details concerning the sensor hub registers are available in *Section 14: Sensor hub register mapping* and *Section 15: Sensor hub register description*.

9.2 PIN_CTRL (02h)

SDO, OCS_AUX, SDO_AUX pins pull-up enable/disable register (r/w)

Table 23. PIN_CTRL register

OIS_PU_DIS	SDO_PU_EN	1	1	1	1	1	1

Table 24. PIN_CTRL register description

OIS_PU_DIS	Disable pull-up on both OCS_Aux and SDO_Aux pins. 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	Enable pull-up on SDO pin (0: SDO pin pull-up disconnected (default); 1: SDO pin with pull-up)

9.3 FIFO_CTRL1 (07h)

FIFO control register 1 (r/w)

Table 25. FIFO_CTRL1 register

WTM7	WTM6	WTM5	WTM4	WTM3	WTM2	WTM1	WTM0

Table 26. FIFO_CTRL1 register description

WTM[7:0]	FIFO watermark threshold, in conjunction with WTM8 in *FIFO_CTRL2 (08h)* 1 LSB = 1 sensor (6 bytes) + TAG (1 byte) written in FIFO Watermark flag rises when the number of bytes written in the FIFO is greater than or equal to the threshold level.

9.4 FIFO_CTRL2 (08h)

FIFO control register 2 (r/w)

Table 27. FIFO_CTRL2 register

STOP_ON_WTM	FIFO_COMPR_RT_EN	0	ODRCHG_EN	0	UNCOPTR_RATE_1	UNCOPTR_RATE_0	WTM8

Table 28. FIFO_CTRL2 register description

STOP_ON_WTM	Sensing chain FIFO stop values memorization at threshold level (0: FIFO depth is not limited (default); 1: FIFO depth is limited to threshold level, defined in *FIFO_CTRL1 (07h)* and *FIFO_CTRL2 (08h)*)
FIFO_COMPR_RT_EN(1)	Enables/Disables compression algorithm runtime
ODRCHG_EN	Enables ODR CHANGE virtual sensor to be batched in FIFO
UNCOPTR_RATE_[1:0]	This field configures the compression algorithm to write non-compressed data at each rate. (0: Non-compressed data writing is not forced; 1: Non-compressed data every 8 batch data rate; 2: Non-compressed data every 16 batch data rate; 3: Non-compressed data every 32 batch data rate)
WTM8	FIFO watermark threshold, in conjunction with WTM_FIFO[7:0] in *FIFO_CTRL1 (07h)* 1 LSB = 1 sensor (6 bytes) + TAG (1 byte) written in FIFO Watermark flag rises when the number of bytes written in the FIFO is greater than or equal to the threshold level.

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

9.5 FIFO_CTRL3 (09h)

FIFO control register 3 (r/w)

Table 29. 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 30. FIFO_CTRL3 register description

BDR_GY_[3:0]	Selects Batching Data Rate (writing frequency in FIFO) for gyroscope data. (0000: Gyro not batched in FIFO (default); 0001: 12.5 Hz; 0010: 26 Hz; 0011: 52 Hz; 0100: 104 Hz; 0101: 208 Hz; 0110: 417 Hz; 0111: 833 Hz; 1000: 1667 Hz; 1001: 3333 Hz; 1010: 6667 Hz; 1011: 6.5 Hz; 1100-1111: not allowed)
BDR_XL_[3:0]	Selects Batching Data Rate (writing frequency in FIFO) for accelerometer data. (0000: Accelerometer not batched in FIFO (default); 0001: 12.5 Hz; 0010: 26 Hz; 0011: 52 Hz; 0100: 104 Hz; 0101: 208 Hz; 0110: 417 Hz; 0111: 833 Hz; 1000: 1667 Hz; 1001: 3333 Hz; 1010: 6667 Hz; 1011: 1.6 Hz; 1100-1111: not allowed)

9.6 FIFO_CTRL4 (0Ah)

FIFO control register 4 (r/w)

Table 31. FIFO_CTRL4 register

DEC_TS_ BATCH_1	DEC_TS_ BATCH_0	ODR_T_ BATCH_1	ODR_T_ BATCH_0	0	FIFO_ MODE2	FIFO_ MODE1	FIFO_ MODE0

Table 32. FIFO_CTRL4 register description

DEC_TS_ BATCH_[1:0]	Selects decimation for timestamp batching in FIFO. Writing rate will be the maximum rate between XL and GYRO 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 batching data rate (writing frequency in FIFO) for temperature data (00: Temperature not batched in FIFO (default); 01: 1.6 Hz; 10: 12.5 Hz; 11: 52 Hz)
FIFO_ MODE[2:0]	FIFO mode selection (000: Bypass mode: FIFO disabled; 001: FIFO mode: stops collecting data when FIFO is full; 010: Reserved; 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.)

9.7 COUNTER_BDR_REG1 (0Bh)

Counter batch data rate register 1 (r/w)

Table 33. COUNTER_BDR_REG1 register

dataready_pulsed	RST_COUNTER_BDR	TRIG_COUNTER_BDR	0	0	CNT_BDR_TH_10	CNT_BDR_TH_9	CNT_BDR_TH_8

Table 34. COUNTER_BDR_REG1 register description

dataready_pulsed	Enables pulsed data-ready mode (0: Data-ready latched mode (returns to 0 only after an interface reading) (default); 1: Data-ready pulsed mode (the data ready pulses are 75 µs long)
RST_COUNTER_BDR	Resets the internal counter of batching events for a single sensor. This bit is automatically reset to zero if it was set to '1'.
TRIG_COUNTER_BDR	Selects the trigger for the internal counter of batching events between XL and gyro. (0: XL batching event; 1: GYRO batching event)
CNT_BDR_TH_[10:8]	In conjunction with CNT_BDR_TH_[7:0] in *COUNTER_BDR_REG2 (0Ch)*, sets the threshold for the internal counter of batching events. When this counter reaches the threshold, the counter is reset and the COUNTER_BDR_IA flag in *FIFO_STATUS2 (3Bh)* is set to '1'.

9.8 COUNTER_BDR_REG2 (0Ch)

Counter batch data rate register 2 (r/w)

Table 35. 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 36. COUNTER_BDR_REG2 register description

CNT_BDR_TH_[7:0]	In conjunction with CNT_BDR_TH_[10:8] in *COUNTER_BDR_REG1 (0Bh)*, sets the threshold for the internal counter of batching events. When this counter reaches the threshold, the counter is reset and the COUNTER_BDR_IA flag in *FIFO_STATUS2 (3Bh)* is set to '1'.

9.9 INT1_CTRL (0Dh)

INT1 pin control register (r/w)

Each bit in this register enables a signal to be carried out on INT1. The output of the pin will be the OR combination of the signals selected here and in *MD1_CFG (5Eh)*.

Table 37. INT1_CTRL register

DEN_ DRDY_ flag	INT1_CNT _BDR	INT1_ FIFO _FULL	INT1_ FIFO_ OVR	INT1_ FIFO_TH	INT1_ BOOT	INT1_ DRDY_G	INT1_ DRDY_XL

Table 38. INT1_CTRL register description

DEN_DRDY_flag	Sends DEN_DRDY (DEN stamped on Sensor Data flag) to INT1 pin.
INT1_CNT_BDR	Enables COUNTER_BDR_IA interrupt on INT1.
INT1_FIFO_FULL	Enables FIFO full flag interrupt on INT1 pin.
INT1_FIFO_OVR	Enables FIFO overrun interrupt on INT1 pin.
INT1_FIFO_TH	Enables FIFO threshold interrupt on INT1 pin.
INT1_BOOT	Enables boot status on INT1 pin
INT1_DRDY_G	Enables gyroscope data-ready interrupt on INT1 pin.
INT1_DRDY_XL	Enables accelerometer data-ready interrupt on INT1 pin.

9.10 INT2_CTRL (0Eh)

INT2 pin control register (r/w)

Each bit in this register enables a signal to be carried out on INT2. The output of the pin will be the OR combination of the signals selected here and in *MD2_CFG (5Fh)*.

Table 39. INT2_CTRL register

0	INT2_CNT _BDR	INT2_ FIFO_ FULL	INT2_ FIFO_ OVR	INT2_ FIFO_TH	INT2_DRDY _TEMP	INT2_ DRDY_G	INT2_ DRDY_XL

Table 40. INT2_CTRL register description

INT2_CNT_BDR	Enables COUNTER_BDR_IA interrupt on INT2.
INT2_FIFO_FULL	Enables FIFO full flag interrupt on INT2 pin.
INT2_FIFO_OVR	Enables FIFO overrun interrupt on INT2 pin.
INT_FIFO_TH	Enables FIFO threshold interrupt on INT2 pin.
INT2_DRDY_TEMP	Enables temperature sensor data-ready interrupt on INT2 pin.
INT2_DRDY_G	Gyroscope data-ready interrupt on INT2 pin
INT2_DRDY_XL	Accelerometer data-ready interrupt on INT2 pin

9.11 WHO_AM_I (0Fh)

WHO_AM_I register (r). This is a read-only register. Its value is fixed at 6Bh.

Table 41. WhoAmI register

0	1	1	0	1	0	1	1

9.12 CTRL1_XL (10h)

Accelerometer control register 1 (r/w)

Table 42. CTRL1_XL register

ODR_XL3	ODR_XL2	ODR_XL1	ODR_XL0	FS1_XL	FS0_XL	LPF2_XL_EN	0

Table 43. CTRL1_XL register description

ODR_XL[3:0]	Accelerometer ODR selection (see *Table 44*)
FS[1:0]_XL	Accelerometer full-scale selection. Default value: 00. (00: ±2 *g*; 01: ±16 *g*; 10: ±4 *g*; 11: ±8 *g*)
LPF2_XL_EN	Accelerometer high-resolution selection (0: output from first stage digital filtering selected (default); 1: output from LPF2 second filtering stage selected)

Table 44. Accelerometer ODR register setting

ODR_XL3	ODR_XL2	ODR_XL1	ODR_XL0	ODR selection [Hz] when XL_HM_MODE = 1 in *CTRL6_C (15h)*	ODR selection [Hz] when XL_HM_MODE = 0 in *CTRL6_C (15h)*
0	0	0	0	Power-down	Power-down
1	0	1	1	1.6 Hz (low power only)	12.5 Hz (high performance)
0	0	0	1	12.5 Hz (low power)	12.5 Hz (high performance)
0	0	1	0	26 Hz (low power)	26 Hz (high performance)
0	0	1	1	52 Hz (low power)	52 Hz (high performance)
0	1	0	0	104 Hz (normal mode)	104 Hz (high performance)
0	1	0	1	208 Hz (normal mode)	208 Hz (high performance)
0	1	1	0	416 Hz (high performance)	416 Hz (high performance)
0	1	1	1	833 Hz (high performance)	833 Hz (high performance)
1	0	0	0	1.66 kHz (high performance)	1.66 kHz (high performance)
1	0	0	1	3.33 kHz (high performance)	3.33 kHz (high performance)
1	0	1	0	6.66 kHz (high performance)	6.66 kHz (high performance)
1	1	x	x	Not allowed	Not allowed

9.13 CTRL2_G (11h)

Gyroscope control register 2 (r/w)

Table 45. CTRL2_G register

ODR_G3	ODR_G2	ODR_G1	ODR_G0	FS1_G	FS0_G	FS_125	FS_4000

Table 46. CTRL2_G register description

ODR_G[3:0]	Gyroscope output data rate selection. Default value: 0000 (Refer to *Table 47*)
FS[1:0]_G	Gyroscope GP chain full-scale selection (00: 250 dps; 01: 500 dps; 10: 1000 dps; 11: 2000 dps)
FS_125	Selects gyro GP chain full-scale 125 dps (0: FS selected through bits FS[1:0]_G; 1: FS set to 125 dps)
FS_4000(1)	Selects gyro GP chain full-scale 4000 dps (0: FS selected through bits FS[1:0]_G or FS_125; 1: FS set to 4000 dps)

1. This bit has to be set to 0 when the OIS chain is ON (OIS_EN_SPI2 bit =1 in the *CTRL1_OIS (70h)* register)

Table 47. Gyroscope ODR configuration setting

ODR_G3	ODR_G2	ODR_G1	ODR_G0	ODR [Hz] when G_HM_MODE = 1 in *CTRL7_G (16h)*	ODR [Hz] when G_HM_MODE = 0 in *CTRL7_G (16h)*
0	0	0	0	Power down	Power down
0	0	0	1	12.5 Hz (low power)	12.5 Hz (high performance)
0	0	1	0	26 Hz (low power)	26 Hz (high performance)
0	0	1	1	52 Hz (low power)	52 Hz (high performance)
0	1	0	0	104 Hz (normal mode)	104 Hz (high performance)
0	1	0	1	208 Hz (normal mode)	208 Hz (high performance)
0	1	1	0	416 Hz (high performance)	416 Hz (high performance)
0	1	1	1	833 Hz (high performance)	833 Hz (high performance)
1	0	0	0	1.66 kHz (high performance)	1.66 kHz (high performance)
1	0	0	1	3.33 kHz (high performance	3.33 kHz (high performance)
1	0	1	0	6.66 kHz (high performance	6.66 kHz (high performance)
1	0	1	1	Not available	Not available

9.14 CTRL3_C (12h)

Control register 3 (r/w)

Table 48. CTRL3_C register

BOOT	BDU	H_LACTIVE	PP_OD	SIM	IF_INC	0	SW_RESET

Table 49. CTRL3_C register description

BOOT	Reboots memory content. Default value: 0 (0: normal mode; 1: reboot memory content) This bit is automatically cleared.
BDU	Block Data Update. Default value: 0 (0: continuous update; 1: output registers are not updated until MSB and LSB have been read)
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)
IF_INC	Register address automatically incremented during a multiple byte access with a serial interface (I^2C or SPI). Default value: 1 (0: disabled; 1: enabled)
SW_RESET	Software reset. Default value: 0 (0: normal mode; 1: reset device) This bit is automatically cleared.

9.15 CTRL4_C (13h)

Control register 4 (r/w)

Table 50. CTRL4_C register

0	SLEEP_G	INT2_on_ INT1	0	DRDY_ MASK	I2C_disable	LPF1_ SEL_G	0

Table 51. CTRL4_C register description

SLEEP_G	Enables gyroscope Sleep mode. Default value:0 (0: disabled; 1: enabled)
INT2_on_INT1	All interrupt signals available on INT1 pin enable. Default value: 0 (0: interrupt signals divided between INT1 and INT2 pins; 1: all interrupt signals in logic or on INT1 pin)
DRDY_MASK	Enables data available (0: disabled; 1: mask DRDY on pin (both XL & Gyro) until filter settling ends (XL and Gyro independently masked).
I2C_disable	Disables I^2C interface. Default value: 0 (0: I^2C, SPI interfaces enabled (default); 1: I^2C interface disabled)
LPF1_SEL_G	Enables gyroscope digital LPF1 if auxiliary SPI is disabled; the bandwidth can be selected through FTYPE [2:0] in *CTRL6_C (15h)*. (0: disabled; 1: enabled)

9.16 CTRL5_C (14h)

Control register 5 (r/w)

Table 52. CTRL5_C register

0	ROUNDING1	ROUNDING0	0	ST1_G	ST0_G	ST1_XL	ST0_XL

Table 53. CTRL5_C register description

ROUNDING[1:0]	Circular burst-mode (rounding) read from the output registers. Default value: 00 (00: no rounding; 01: accelerometer only; 10: gyroscope only; 11: gyroscope + accelerometer)
ST[1:0]_G	Angular rate sensor self-test enable. Default value: 00 (00: Self-test disabled; Other: refer to *Table 54*)
ST[1:0]_XL	Linear acceleration sensor self-test enable. Default value: 00 (00: Self-test disabled; Other: refer to *Table 55*)

Table 54. Angular rate sensor self-test mode selection

ST1_G	ST0_G	Self-test mode
0	0	Normal mode
0	1	Positive sign self-test
1	0	Not allowed
1	1	Negative sign self-test

Table 55. Linear acceleration sensor self-test mode selection

ST1_XL	ST0_XL	Self-test mode
0	0	Normal mode
0	1	Positive sign self-test
1	0	Negative sign self-test
1	1	Not allowed

9.17 CTRL6_C (15h)

Control register 6 (r/w)

Table 56. CTRL6_C register

TRIG_EN	LVL1_EN	LVL2_EN	XL_HM_MODE	USR_ OFF_W	FTYPE_2	FTYPE_1	FTYPE_0

Table 57. CTRL6_C register description

TRIG_EN	DEN data edge-sensitive trigger enable. Refer to *Table 58*.
LVL1_EN	DEN data level-sensitive trigger enable. Refer to *Table 58*.
LVL2_EN	DEN level-sensitive latched enable. Refer to*Table 58*.
XL_HM_MODE	High-performance operating mode disable for accelerometer. Default value: 0 (0: high-performance operating mode enabled; 1: high-performance operating mode disabled)
USR_OFF_W	Weight of XL user offset bits of registers *X_OFS_USR (73h)*, *Y_OFS_USR (74h)*, *Z_OFS_USR (75h)* 0 = 2^{-10} *g*/LSB 1 = 2^{-6} *g*/LSB
FTYPE[2:0]	Gyroscope's low-pass filter (LPF1) bandwidth selection *Table 58* shows the selectable bandwidth values (available if auxiliary SPI is disabled).

Table 58. Trigger mode selection

TRIG_EN, LVL1_EN, LVL2_EN	Trigger mode
100	Edge-sensitive trigger mode is selected
010	Level-sensitive trigger mode is selected
011	Level-sensitive latched mode is selected
110	Level-sensitive FIFO enable mode is selected

Table 59. Gyroscope LPF1 bandwidth selection

FTYPE [2:0]	12.5 Hz	26 Hz	52 Hz	104 Hz	208 Hz	416 Hz	833 Hz	1.67 kHz	3.33 kHz	6.67 kHz
000	4.3	8.3	16.7	33	67	133	222	274	292	297
001	4.3	8.3	16.7	33	67	128	186	212	220	223
010	4.3	8.3	16.7	33	67	112	140	150	153	154
011	4.3	8.3	16.7	33	67	134	260	390	451	470
100	4.3	8.3	16.7	34	62	86	96	90	NA	
101	4.3	8.3	16.9	31	43	48	49	50	NA	
110	4.3	8.3	13.4	19	23	24.6	25	25	NA	
111	4.3	8.3	9.8	11.6	12.2	12.4	12.6	12.6	NA	

9.18 CTRL7_G (16h)

Control register 7 (r/w)

Table 60. CTRL7_G register

G_HM_MODE	HP_EN_G	HPM1_G	HPM0_G	0(1)	OIS_ON_EN	USR_OFF_ON_OUT	OIS_ON

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

Table 61. CTRL7_G register description

G_HM_MODE	Disables high-performance operating mode for gyroscope. Default: 0 (0: high-performance operating mode enabled; 1: high-performance operating mode disabled)
HP_EN_G	Enables gyroscope digital high-pass filter. The filter is enabled only if the gyro is in HP mode. Default value: 0 (0: HPF disabled; 1: HPF enabled)
HPM_G[1:0]	Gyroscope digital HP filter cutoff selection. Default: 00 (00: 16 mHz; 01: 65 mHz; 10: 260 mHz; 11: 1.04 Hz)
OIS_ON_EN(1)	Selects how to enable and disable the OIS chain, after first configuration and enabling through SPI2. (0: OIS chain is enabled/disabled with SPI2 interface; 1: OIS chain is enabled/disabled with primary interface)
USR_OFF_ON_OUT	Enables accelerometer user offset correction block; it's valid for the low-pass path - see *Figure 16: Accelerometer composite filter*. Default value: 0 (0: accelerometer user offset correction block bypassed; 1: accelerometer user offset correction block enabled)
OIS_ON(1)	Enables/disables the OIS chain from primary interface when the OIS_ON_EN bit is '1'. (0: OIS disabled; 1: OIS enabled)

1. First, enabling OIS and OIS configurations must be done through SPI2, with OIS_ON_EN and OIS_ON set to '0'.

9.19 CTRL8_XL (17h)

Control register 8 (r/w)

Table 62. CTRL8_XL register

HPCF_XL_2	HPCF_XL_1	HPCF_XL_0	HP_REF_MODE_XL	FASTSETTL_MODE_XL	HP_SLOPE_XL_EN	0(1)	LOW_PASS_ON_6D

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

Table 63. CTRL8_XL register description

HPCF_XL_[2:0]	Accelerometer LPF2 and HP filter configuration and cutoff setting. Refer to *Table 64*.
HP_REF_MODE_XL	Enables accelerometer high-pass filter reference mode (valid for high-pass path - HP_SLOPE_XL_EN bit must be '1' and HPCF_XL = "111"). Default value: 0 (0: disabled, 1: enabled(1))
FASTSETTL_MODE_XL	Enables accelerometer LPF2 and HPF fast-settling mode. The filter sets the second samples 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 23*.
LOW_PASS_ON_6D	LPF2 on 6D function selection. Refer to *Figure 23*. Default value: 0 (0: ODR/2 low-pass filtered data sent to 6D interrupt function; 1: LPF2 output data sent to 6D interrupt function)

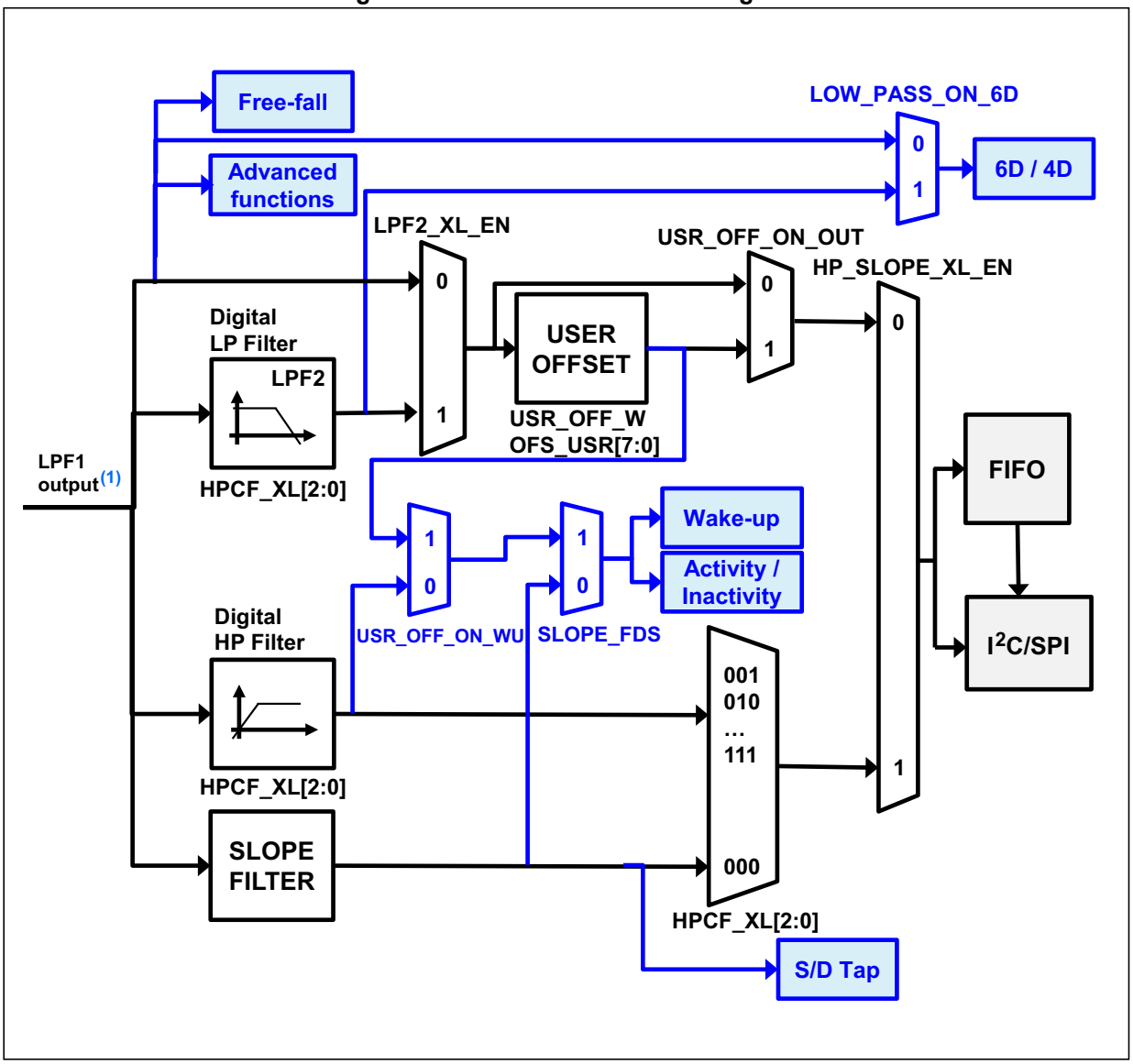
1. When enabled, the first output data have to be discarded.

Table 64. Accelerometer bandwidth configurations

Filter type	HP_SLOPE_XL_EN	LPF2_XL_EN	HPCF_XL_[2:0]	Bandwidth(1)
Low pass	0	0	-	ODR/2
		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. Typical value for ODR up to 833 Hz

Figure 23. Accelerometer block diagram



1. The cutoff value of the LPF1 output is ODR/2 when the accelerometer is in high-performance mode and ODR up to 833 Hz. This value is equal to 780 Hz when the accelerometer is in low-power or normal mode.

9.20 CTRL9_XL (18h)

Control register 9 (r/w)

Table 65. CTRL9_XL register

DEN_X	DEN_Y	DEN_Z	DEN_XL_G	DEN_XL_EN	DEN_LH	1	0(1)

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

Table 66. CTRL9_XL register description

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 [7:5]; 1: DEN pin info stamped in the accelerometer axis selected by bits [7:5])
DEN_XL_EN	Extends DEN functionality to accelerometer sensor. Default value: 0 (0: disabled; 1: enabled)
DEN_LH	DEN active level configuration. Default value: 0 (0: active low; 1: active high)

9.21 CTRL10_C (19h)

Control register 10 (r/w)

Table 67. CTRL10_C register

0	0	TIMESTAMP_EN	0	0	0	0	0

Table 68. CTRL10_C register description

TIMESTAMP_EN	Enables timestamp counter. default value: 0 (0: disabled; 1: enabled) The counter is readable in *TIMESTAMP0 (40h), TIMESTAMP1 (41h), TIMESTAMP2 (42h), and TIMESTAMP3 (43h)*.

9.22 ALL_INT_SRC (1Ah)

Source register for all interrupts (r)

Table 69. ALL_INT_SRC register

TIMESTAMP_ ENDCOUNT	0	SLEEP_ CHANGE_ IA	D6D_IA	DOUBLE_ TAP	SINGLE_ TAP	WU_IA	FF_IA

Table 70. ALL_INT_SRC register description

TIMESTAMP_ENDCOUNT	Alerts timestamp overflow within 6.4 ms
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)
DOUBLE_TAP	Double-tap event status. Default value: 0 (0:event not detected, 1: event detected)
SINGLE_TAP	Single-tap event status. Default value:0 (0: event not detected, 1: 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)

9.23 WAKE_UP_SRC (1Bh)

Wake-up interrupt source register (r)

Table 71. WAKE_UP_SRC register

0	SLEEP_ CHANGE_IA	FF_IA	SLEEP_ STATE	WU_IA	X_WU	Y_WU	Z_WU

Table 72. 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 event status. Default value: 0 (0: sleep event not detected; 1: sleep event detected)
WU_IA	Wakeup event detection status. Default value: 0 (0: wakeup event not detected; 1: wakeup event detected.)
X_WU	Wakeup event detection status on X-axis. Default value: 0 (0: wakeup event on X-axis not detected; 1: wakeup event on X-axis detected)
Y_WU	Wakeup event detection status on Y-axis. Default value: 0 (0: wakeup event on Y-axis not detected; 1: wakeup event on Y-axis detected)
Z_WU	Wakeup event detection status on Z-axis. Default value: 0 (0: wakeup event on Z-axis not detected; 1: wakeup event on Z-axis detected)

9.24 TAP_SRC (1Ch)

Tap source register (r).

Table 73. TAP_SRC register

0	TAP_IA	SINGLE_TAP	DOUBLE_TAP	TAP_SIGN	X_TAP	Y_TAP	Z_TAP

Table 74. 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)

9.25 D6D_SRC (1Dh)

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

Table 75. D6D_SRC register

DEN_DRDY	D6D_IA	ZH	ZL	YH	YL	XH	XL

Table 76. D6D_SRC register description

DEN_DRDY	DEN data-ready signal. It is set high when data output is related to the data coming from a DEN active condition.(1)
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)

1. The DEN data-ready signal can be latched or pulsed depending on the value of the dataready_pulsed bit of the *COUNTER_BDR_REG1 (0Bh)* register.

9.26 STATUS_REG (1Eh) / STATUS_SPIAux (1Eh)

The STATUS_REG register is read by the primary interface I^2C/SPI (r).

Table 77. STATUS_REG register

0	0	0	0	0	TDA	GDA	XLDA

Table 78. STATUS_REG register description

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)

The STATUS_SPIAux register is read by the auxiliary SPI.

Table 79. STATUS_SPIAux register

0	0	0	0	0	GYRO_ SETTLING	GDA	XLDA

Table 80. STATUS_SPIAux 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)

9.27 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 81. OUT_TEMP_L register

Temp7	Temp6	Temp5	Temp4	Temp3	Temp2	Temp1	Temp0

Table 82. OUT_TEMP_H register

Temp15	Temp14	Temp13	Temp12	Temp11	Temp10	Temp9	Temp8

Table 83. OUT_TEMP register description

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

9.28 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.

If this register is read by the primary interface, data are according to the full scale and ODR settings (*CTRL2_G (11h)*) of gyro user interface.

If this register is read by the auxiliary interface, data are according to the full scale and ODR (6.66 kHz) settings of the OIS gyro.

Table 84. OUTX_L_G register

D7	D6	D5	D4	D3	D2	D1	D0

Table 85. OUTX_H_G register

D15	D14	D13	D12	D11	D10	D9	D8

Table 86. OUTX_H_G register description

D[15:0]	Pitch axis (X) angular rate value D[15:0] expressed in two's complement and its value depends on the interface used: SPI1/I^{2}C: Gyro GP chain pitch axis output SPI2: Gyro OIS chain pitch axis output

9.29 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.

If this register is read by the primary interface, data are according to the full scale and ODR settings (*CTRL2_G (11h)*) of the gyro user interface.

If this register is read by the auxiliary interface, data are according to the full scale and ODR (6.66 kHz) settings of the OIS gyro.

Table 87. OUTY_L_G register

D7	D6	D5	D4	D3	D2	D1	D0

Table 88. OUTY_H_G register

D15	D14	D13	D12	D11	D10	D9	D8

Table 89. OUTY_H_G register description

D[15:0]	Roll axis (Y) angular rate value D[15:0] expressed in two's complement and its value depends on the interface used: SPI1/I^{2}C: Gyro GP chain roll axis output SPI2: Gyro OIS chain roll axis output

9.30 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.

If this register is read by the primary interface, data are according to the full scale and ODR settings (*CTRL2_G (11h)*) of the gyro user interface.

If this register is read by the auxiliary interface, data are according to the full scale and ODR (6.66 kHz) settings of the OIS gyro.

Table 90. OUTZ_L_G register

D7	D6	D5	D4	D3	D2	D1	D0

Table 91. OUTZ_H_G register

D15	D14	D13	D12	D11	D10	D9	D8

Table 92. OUTZ_H_G register description

D[15:0]	Yaw axis (Z) angular rate value D[15:0] expressed in two's complement and its value depends on the interface used: SPI1/I^2C: Gyro GP chain yaw axis output SPI2: Gyro OIS chain yaw axis output

9.31 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.

If this register is read by the primary interface, data are according to the full-scale and ODR settings (*CTRL1_XL (10h)*) of the accelerometer user interface.

If this register is read by the auxiliary interface, data are according to the full-scale and ODR (6.66 kHz) settings of the OIS (*CTRL3_OIS (72h)*).

Table 93. OUTX_L_A register

D7	D6	D5	D4	D3	D2	D1	D0

Table 94. OUTX_H_A register

D15	D14	D13	D12	D11	D10	D9	D8

Table 95. OUTX_H_A register description

D[15:0]	X-axis linear acceleration value. D[15:0] expressed in two's complement and its value depends on the interface used: SPI1/I^2C: Accelerometer GP chain X-axis output SPI2: Accelerometer OIS chain X-axis output

9.32 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.

If this register is read by the primary interface, data are according to the full-scale and ODR settings (*CTRL1_XL (10h)*) of the accelerometer user interface.

If this register is read by the auxiliary interface, data are according to the full-scale and ODR (6.66 kHz) settings of the OIS (*CTRL3_OIS (72h)*).

Table 96. OUTY_L_A register

D7	D6	D5	D4	D3	D2	D1	D0

Table 97. OUTY_H_A register

D15	D14	D13	D12	D11	D10	D9	D8

Table 98. OUTY_H_A register description

D[15:0]	Y-axis linear acceleration value D[15:0] expressed in two's complement and its value depends on the interface used: SPI1/I^2C: Accelerometer GP chain Y-axis output SPI2: Accelerometer OIS chain Y-axis output

9.33 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.

If this register is read by the primary interface, data are according to the full-scale and ODR settings (*CTRL1_XL (10h)*) of the accelerometer user interface.

If this register is read by the auxiliary interface, data are according to the full-scale and ODR (6.66 kHz) settings of the OIS (*CTRL3_OIS (72h)*).

Table 99. OUTZ_L_A register

D7	D6	D5	D4	D3	D2	D1	D0

Table 100. OUTZ_H_A register

D15	D14	D13	D12	D11	D10	D9	D8

Table 101. OUTZ_H_A register description

D[15:0]	Z-axis linear acceleration value D[15:0] expressed in two's complement and its value depends on the interface used: SPI1/I^2C: Accelerometer GP chain Z-axis output SPI2: Accelerometer OIS chain Z-axis output

9.34 EMB_FUNC_STATUS_MAINPAGE (35h)

Embedded function status register (r).

Table 102. EMB_FUNC_STATUS_MAINPAGE register

IS_FSM_LC	0	IS_ SIGMOT	IS_ TILT	IS_STEP_ DET	0	0	0

Table 103. 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)

9.35 FSM_STATUS_A_MAINPAGE (36h)

Finite State Machine status register (r).

Table 104. FSM_STATUS_A_MAINPAGE register

IS_FSM8	IS_FSM7	IS_FSM6	IS_FSM5	IS_FSM4	IS_FSM3	IS_FSM2	IS_FSM1

Table 105. FSM_STATUS_A_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)

9.36 FSM_STATUS_B_MAINPAGE (37h)

Finite State Machine status register (r).

Table 106. FSM_STATUS_B_MAINPAGE register

IS_FSM16	IS_FSM15	IS_FSM14	IS_FSM13	IS_FSM12	IS_FSM11	IS_FSM10	IS_FSM9

Table 107. FSM_STATUS_B_MAINPAGE register description

IS_FSM16	Interrupt status bit for FSM16 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM15	Interrupt status bit for FSM15 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM14	Interrupt status bit for FSM14 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM13	Interrupt status bit for FSM13 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM12	Interrupt status bit for FSM12 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM11	Interrupt status bit for FSM11 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM10	Interrupt status bit for FSM10 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM9	Interrupt status bit for FSM9 interrupt event. (1: interrupt detected; 0: no interrupt)

9.37 MLC_STATUS_MAINPAGE (38h)

Machine Learning Core status register (r).

Table 108. MLC_STATUS _MAINPAGE register

IS_MLC8	IS_MLC7	IS_MLC6	IS_MLC5	IS_MLC4	IS_MLC3	IS_MLC2	IS_MLC1

Table 109. MLC_STATUS_MAINPAGE register description

IS_MLC8	Interrupt status bit for MLC8 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_MLC7	Interrupt status bit for MLC7 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_MLC6	Interrupt status bit for MLC6 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_MLC5	Interrupt status bit for MLC5 interrupt event. (1: interrupt detected; 0: no interrupt)
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)

9.38 STATUS_MASTER_MAINPAGE (39h)

Sensor hub source register (r).

Table 110. STATUS_MASTER_MAINPAGE register

WR_ ONCE_ DONE	SLAVE3_ NACK	SLAVE2_ NACK	SLAVE1_ NACK	SLAVE0_ NACK	0	0	SENS_HUB_ ENDOP

Table 111. 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)

9.39 FIFO_STATUS1 (3Ah)

FIFO status register 1 (r)

Table 112. 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 113. FIFO_STATUS1 register description

DIFF_ FIFO_[7:0]	Number of unread sensor data (TAG + 6 bytes) stored in FIFO In conjunction with DIFF_FIFO[9:8] in *FIFO_STATUS2 (3Bh).*

9.40 FIFO_STATUS2 (3Bh)

FIFO status register 2 (r)

Table 114. FIFO_STATUS2 register

FIFO_ WTM_IA	FIFO_ OVR_IA	FIFO_ FULL_IA	COUNTER _BDR_IA	FIFO_OVR_ LATCHED	0(1)	DIFF_ FIFO_9	DIFF_ FIFO_8

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

Table 115. 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[8:0] 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_[9:8]	Number of unread sensor data (TAG + 6 bytes) stored in FIFO. Default value: 00 In conjunction with DIFF_FIFO[7:0] in *FIFO_STATUS1 (3Ah)*

9.41 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 25 µs.

Table 116. 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 117. TIMESTAMP output register description

D[31:0]	Timestamp output registers: 1LSB = 25 µs

The formula below can be used to calculate a better estimation of the actual timestamp resolution:

TS_Res = 1 / (40000 + (0.0015 * INTERNAL_FREQ_FINE * 40000))

where INTERNAL_FREQ_FINE is the content of *INTERNAL_FREQ_FINE (63h)*.

9.42 TAP_CFG0 (56h)

Activity/inactivity functions, configuration of filtering, and tap recognition functions (r/w).

Table 118. TAP_CFG0 register

0	INT_CLR_ ON_READ	SLEEP_ STATUS_ ON_INT	SLOPE_ FDS	TAP_X_EN	TAP_Y_EN	TAP_Z_EN	LIR

Table 119. TAP_CFG0 register description

INT_CLR_ON_ READ	This bit allows immediately clearing the latched interrupts of an event detection upon the read of the corresponding status register. It must be set to 1 together with LIR. Default value: 0 (0: latched interrupt signal cleared at the end of the ODR period; 1: latched interrupt signal immediately cleared)
SLEEP_ STATUS_ON_ INT	Activity/inactivity interrupt mode configuration. If INT1_SLEEP_CHANGE or INT2_SLEEP_CHANGE bits are enabled, drives the sleep status or sleep change on the INT pins. Default value: 0 (0: sleep change notification on INT pins; 1: sleep status reported on INT pins)
SLOPE_FDS	HPF or SLOPE filter selection on wake-up and Activity/Inactivity functions. Default value: 0 (0: SLOPE filter applied; 1: HPF applied)
TAP_X_EN	Enable X direction in tap recognition. Default value: 0 (0: X direction disabled; 1: X direction enabled)
TAP_Y_EN	Enable Y direction in tap recognition. Default value: 0 (0: Y direction disabled; 1: Y direction enabled)
TAP_Z_EN	Enable 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)

9.43 TAP_CFG1 (57h)

Tap configuration register (r/w)

Table 120. 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 121. TAP_CFG1 register description

TAP_PRIORITY_[2:0]	Selection of axis priority for TAP detection (see *Table 122*)
TAP_THS_X_[4:0]	X-axis tap recognition threshold. Default value: 0 1 LSB = FS_XL / (2^5)

Table 122. 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

9.44 TAP_CFG2 (58h)

Enables interrupt and inactivity functions, and tap recognition functions (r/w).

Table 123. TAP_CFG2 register

INTERRUPTS_ENABLE	INACT_EN1	INACT_EN0	TAP_THS_Y_4	TAP_THS_Y_3	TAP_THS_Y_2	TAP_THS_Y_1	TAP_THS_Y_0

Table 124. TAP_CFG2 register description

INTERRUPTS_ENABLE	Enable basic interrupts (6D/4D, free-fall, wake-up, tap, inactivity). Default value: 0 (0: interrupt disabled; 1: interrupt enabled)
INACT_EN[1:0]	Enable activity/inactivity (sleep) function. Default value: 00 (00: stationary/motion-only interrupts generated, XL and gyro do not change; 01: sets accelerometer ODR to 12.5 Hz (low-power mode), gyro does not change; 10: sets accelerometer ODR to 12.5 Hz (low-power mode), gyro to sleep mode; 11: sets accelerometer ODR to 12.5 Hz (low-power mode), gyro to power-down mode)
TAP_THS_Y_[4:0]	Y-axis tap recognition threshold. Default value: 0 1 LSB = FS_XL / (2^5)

9.45 TAP_THS_6D (59h)

Portrait/landscape position and tap function threshold register (r/w).

Table 125. TAP_THS_6D register

D4D_EN	SIXD_THS1	SIXD_THS0	TAP_THS_Z_4	TAP_THS_Z_3	TAP_THS_Z_2	TAP_THS_Z_1	TAP_THS_Z_0

Table 126. TAP_THS_6D register description

D4D_EN	4D orientation detection enable. Z-axis position detection is disabled. Default value: 0 (0: enabled; 1: disabled)
SIXD_THS[1:0]	Threshold for 4D/6D function. Default value: 00 For details, refer to *Table 127*.
TAP_THS_Z_[4:0]	Z-axis recognition threshold. Default value: 0 1 LSB = FS_XL / (2^5)

Table 127. Threshold for D4D/D6D function

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

9.46 INT_DUR2 (5Ah)

Tap recognition function setting register (r/w).

Table 128. INT_DUR2 register

DUR3	DUR2	DUR1	DUR0	QUIET1	QUIET0	SHOCK1	SHOCK0

Table 129. INT_DUR2 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.

9.47 WAKE_UP_THS (5Bh)

Single/double-tap selection and wake-up configuration (r/w)

Table 130. WAKE_UP_THS register

SINGLE_ DOUBLE_ TAP	USR_OFF _ON_WU	WK_THS5	WK_THS4	WK_THS3	WK_THS2	WK_THS1	WK_THS0

Table 131. WAKE_UP_THS register description

SINGLE_ DOUBLE_TAP	Single/double-tap event enable. Default: 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 wakeup function.
WK_THS[5:0]	Threshold for wakeup: 1 LSB weight depends on WAKE_THS_W in *WAKE_UP_DUR (5Ch)*. Default value: 000000

9.48 WAKE_UP_DUR (5Ch)

Free-fall, wakeup and sleep mode functions duration setting register (r/w)

Table 132. WAKE_UP_DUR register

FF_DUR5	WAKE_ DUR1	WAKE_ DUR0	WAKE_ THS_W	SLEEP_ DUR3	SLEEP_ DUR2	SLEEP_ DUR1	SLEEP_ DUR0

Table 133. WAKE_UP_DUR register description

FF_DUR5	Free fall duration event. Default: 0 For the complete configuration of the free-fall duration, refer to FF_DUR[4:0] in *FREE_FALL (5Dh)* configuration. 1 LSB = 1 ODR_time
WAKE_DUR[1:0]	Wake up duration event. Default: 00 1LSB = 1 ODR_time
WAKE_THS_W	Weight of 1 LSB of wakeup threshold. Default: 0 (0: 1 LSB = FS_XL / (2^6); 1: 1 LSB = FS_XL / (2^8))
SLEEP_DUR[3:0]	Duration to go in sleep mode. Default value: 0000 (this corresponds to 16 ODR) 1 LSB = 512 ODR

9.49 FREE_FALL (5Dh)

Free-fall function duration setting register (r/w).

Table 134. FREE_FALL register

FF_DUR4	FF_DUR3	FF_DUR2	FF_DUR1	FF_DUR0	FF_THS2	FF_THS1	FF_THS0

Table 135. FREE_FALL register description

FF_DUR[4:0]	Free-fall duration event. Default: 0 For the complete configuration of the free fall duration, refer to FF_DUR5 in *WAKE_UP_DUR (5Ch)* configuration
FF_THS[2:0]	Free fall threshold setting. Default: 000 For details refer to *Table 136*.

Table 136. 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

9.50 MD1_CFG (5Eh)

Functions routing on INT1 register (r/w)

Table 137. MD1_CFG register

INT1_ SLEEP_ CHANGE	INT1_ SINGLE_ TAP	INT1_WU	INT1_FF	INT1_ DOUBLE_ TAP	INT1_6D	INT1_EMB _FUNC	INT1_ SHUB

Table 138. MD1_CFG register description

INT1_SLEEP_ CHANGE(1)	Routing of activity/inactivity recognition event on INT1. Default: 0 (0: routing of activity/inactivity event on INT1 disabled; 1: routing of activity/inactivity event on INT1 enabled)
INT1_SINGLE_ TAP	Routing of single-tap recognition event on INT1. Default: 0 (0: routing of single-tap event on INT1 disabled; 1: routing of single-tap event on INT1 enabled)
INT1_WU	Routing of wakeup event on INT1. Default value: 0 (0: routing of wakeup event on INT1 disabled; 1: routing of wakeup event on INT1 enabled)
INT1_FF	Routing of free-fall event on INT1. Default value: 0 (0: routing of free-fall event on INT1 disabled; 1: routing of free-fall event on INT1 enabled)
INT1_DOUBLE_ TAP	Routing of tap event on INT1. Default value: 0 (0: routing of double-tap event on INT1 disabled; 1: routing of double-tap event on INT1 enabled)
INT1_6D	Routing of 6D event on INT1. Default value: 0 (0: routing of 6D event on INT1 disabled; 1: routing of 6D event on INT1 enabled)
INT1_EMB_ FUNC	Routing of embedded functions event on INT1. Default value: 0 (0: routing of embedded functions event on INT1 disabled; 1: routing embedded functions event on INT1 enabled)
INT1_SHUB	Routing of sensor hub communication concluded event on INT1. Default value: 0 (0: routing of sensor hub communication concluded event on INT1 disabled; 1: routing of sensor hub communication concluded event on INT1 enabled)

1. Activity/Inactivity interrupt mode (sleep change or sleep status) depends on the SLEEP_STATUS_ON_INT bit in *TAP_CFG0 (56h)* register.

9.51 MD2_CFG (5Fh)

Functions routing on INT2 register (r/w)

Table 139. MD2_CFG register

INT2_ SLEEP_ CHANGE	INT2_ SINGLE_ TAP	INT2_WU	INT2_FF	INT2_ DOUBLE_ TAP	INT2_6D	INT2_ EMB_ FUNC	INT2_ TIMESTAMP

Table 140. MD2_CFG register description

INT2_SLEEP_CHANGE(1)	Routing of activity/inactivity recognition event on INT2. Default: 0 (0: routing of activity/inactivity event on INT2 disabled; 1: routing of activity/inactivity event on INT2 enabled)
INT2_SINGLE_TAP	Single-tap recognition routing on INT2. Default: 0 (0: routing of single-tap event on INT2 disabled; 1: routing of single-tap event on INT2 enabled)
INT2_WU	Routing of wakeup event on INT2. Default value: 0 (0: routing of wakeup event on INT2 disabled; 1: routing of wake-up event on INT2 enabled)
INT2_FF	Routing of free-fall event on INT2. Default value: 0 (0: routing of free-fall event on INT2 disabled; 1: routing of free-fall event on INT2 enabled)
INT2_DOUBLE_TAP	Routing of tap event on INT2. Default value: 0 (0: routing of double-tap event on INT2 disabled; 1: routing of double-tap event on INT2 enabled)
INT2_6D	Routing of 6D event on INT2. Default value: 0 (0: routing of 6D event on INT2 disabled; 1: routing of 6D event on INT2 enabled)
INT2_EMB_FUNC	Routing of embedded functions event on INT2. Default value: 0 (0: routing of embedded functions event on INT2 disabled; 1: routing embedded functions event on INT2 enabled)
INT2_TIMESTAMP	Enables routing on INT2 pin of the alert for timestamp overflow within 6.4 ms

1. Activity/Inactivity interrupt mode (sleep change or sleep status) depends on the SLEEP_STATUS_ON_INT bit in *TAP_CFG0 (56h)* register.

9.52 INTERNAL_FREQ_FINE (63h)

Internal frequency register (r)

Table 141. INTERNAL_FREQ_FINE register

FREQ_ FINE7	FREQ_ FINE6	FREQ_ FINE5	FREQ_ FINE4	FREQ_ FINE3	FREQ_ FINE2	FREQ_ FINE1	FREQ_ FINE0

Table 142. 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: 0.15%. 8-bit format, 2's complement.

The formula below can be used to calculate a better estimation of the actual ODR:

ODR_Actual = (6667 + ((0.0015 * INTERNAL_FREQ_FINE) * 6667)) / ODR_Coeff

Selected_ODR	ODR_Coeff
12.5	512
26	256
52	128
104	64
208	32
416	16
833	8
1667	4
3333	2
6667	1

The Selected_ODR parameter has to be derived from the ODR_XL selection (*Table 44: Accelerometer ODR register setting*) in order to estimate the accelerometer ODR and from the ODR_G selection (*Table 47: Gyroscope ODR configuration setting*) in order to estimate the gyroscope ODR.

9.53 INT_OIS (6Fh)

OIS interrupt configuration register and accelerometer self-test enable setting. Primary interface for read-only (r); only Aux SPI can write to this register (r/w).

Table 143. INT_OIS register

INT2_ DRDY_ OIS	LVL2_OIS	DEN_LH_ OIS	0	0	0	ST1_XL_ OIS	ST0_XL_ OIS

Table 144. INT_OIS register description

INT2_DRDY_ OIS	Enables OIS chain DRDY on INT2 pin. This setting has priority over all other INT2 settings.
LVL2_OIS	Enables level-sensitive latched mode on the OIS chain. Default value: 0
DEN_LH_ OIS	Indicates polarity of DEN signal on OIS chain (0: DEN pin is active-low; 1: DEN pin is active-high)
ST[1:0]_XL_ OIS	Selects accelerometer self-test – effective only if XL OIS chain is enabled. Default value: 00 (00: Normal mode; 01: Positive sign self-test; 10: Negative sign self-test; 11: not allowed)

9.54 CTRL1_OIS (70h)

OIS configuration register. Primary interface for read-only (r); only Aux SPI can write to this register (r/w).

Table 145. CTRL1_OIS register

0	LVL1_OIS	SIM_OIS	Mode4_ EN	FS1_G_ OIS	FS0_G_ OIS	FS_125_ OIS	OIS_EN_ SPI2

Table 146. CTRL1_OIS register description

LVL1_OIS	Enables OIS data level-sensitive trigger
SIM_OIS	SPI2 3- or 4-wire interface. Default value: 0 (0: 4-wire SPI2; 1: 3-wire SPI2)
Mode4_EN	Enables accelerometer OIS chain. OIS outputs are available through SPI2 in registers 28h-2Dh. Note: OIS_EN_SPI2 must be enabled (i.e. set to '1') to enable also XL OIS chain.
FS[1:0]_G_ OIS	Selects gyroscope OIS chain full-scale (00: 250 dps; 01: 500 dps; 10: 1000 dps; 11: 2000 dps)
FS_125_OIS	Selects gyroscope OIS chain full-scale 125 dps (0: FS selected through bits FS[1:0]_OIS_G; 1: 125 dps)
OIS_EN_SPI2	Enables OIS chain data processing for gyro in Mode 3 and Mode 4 (mode4_en = 1) and accelerometer data in and Mode 4 (mode4_en = 1). When the OIS chain is enabled, the OIS outputs are available through the SPI2 in registers *OUTX_L_G (22h) and OUTX_H_G (23h)* through and *STATUS_REG (1Eh) / STATUS_SPIAux (1Eh)*, and LPF1 is dedicated to this chain.

DEN mode selection can be done using the LVL1_OIS bit of register *CTRL1_OIS (70h)* and the LVL2_OIS bit of register *INT_OIS (6Fh)*.
DEN mode on the OIS path is active in the gyroscope only.

Table 147. DEN mode selection

LVL1_OIS, LVL2_OIS	DEN mode
10	Level-sensitive trigger mode is selected
11	Level-sensitive latched mode is selected

9.55 CTRL2_OIS (71h)

OIS configuration register. Primary interface for read-only (r); only Aux SPI can write to this register (r/w).

Table 148. CTRL2_OIS register

0	0	HPM1_ OIS	HPM0_ OIS	0	FTYPE_1_ OIS	FTYPE_0_ OIS	HP_EN_ OIS

Table 149. CTRL2_OIS register description

HPM[1:0]_OIS	Selects gyroscope OIS chain digital high-pass filter cutoff. Default value: 00 (00: 16 mHz; 01: 65 mHz; 10: 260 mHz; 11: 1.04 Hz)
FTYPE_[1:0]_OIS	Selects gyroscope digital LPF1 filter bandwidth. *Table 150* shows cutoff and phase values obtained with all configurations.
HP_EN_OIS	Enables gyroscope OIS chain digital high-pass filter

Table 150. Gyroscope OIS chain digital LPF1 filter bandwidth selection

ODR [Hz]	LPF1 FTYPE_[1:0]_OIS	Total BW [Hz] (phase delay @20 Hz)
6.66 kHz	00	297 Hz (7°)
	01	222 Hz (9°)
	10	154 Hz (12°)
	11	470 Hz (5°)

9.56 CTRL3_OIS (72h)

OIS configuration register. Primary interface for read-only (r); only Aux SPI can write to this register (r/w).

Table 151. CTRL3_OIS register

FS1_XL_OIS	FS0_XL_OIS	FILTER_XL_CONF_OIS_2	FILTER_XL_CONF_OIS_1	FILTER_XL_CONF_OIS_0	ST1_OIS	ST0_OIS	ST_OIS_CLAMPDIS

Table 152. CTRL3_OIS register description

FS[1:0]_XL_OIS	Selects accelerometer OIS channel full-scale. Default value: 00. (00: ±2 *g*; 01: ±16 *g*; 10: ±4 *g*; 11: ±8 *g*)
FILTER_XL_CONF_OIS_[2:0]	Selects accelerometer OIS channel bandwidth. See *Table 153*.
ST[1:0]_OIS	Selects gyroscope OIS chain self-test. Default value: 00 *Table 154* lists the output variation when the self-test is enabled and ST_OIS_CLAMPDIS = '1'. (00: Normal mode; 01: Positive sign self-test; 10: Normal mode; 11: Negative sign self-test)
ST_OIS_CLAMPDIS	Disables OIS chain clamp (0: All OIS chain outputs = 8000h during self-test; 1: OIS chain self-test outputs as shown in *Table 154*.

Table 153. Accelerometer OIS channel bandwidth and phase

FILTER_XL_CONF_OIS[2:0]	Typ. overall bandwidth [Hz]	Typ. overall phase [°]
000	631	-4.20 @ 20 Hz
001	295	-6.35 @ 20 Hz
010	140	-10.6 @ 20 Hz
011	68.2	-18.9 @ 20 Hz
100	33.6	-17.8 @ 10 Hz
101	16.7	-32.2 @ 10 Hz
110	8.3	-26.2 @ 4 Hz
111	4.14	-26.0 @ 2 Hz

Table 154. Self-test nominal output variation

Full scale	Output variation [dps]
2000	400
1000	200
500	100
250	50
125	25

9.57 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 155. 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 156. 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 *CTRL6_C (15h)*. The value must be in the range [-127 127].

9.58 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 157. 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 158. Y_OFS_USR register description

Y_OFS_USR_[7:0]	Accelerometer Y-axis user offset calibration expressed in 2's complement, weight depends on USR_OFF_W in *CTRL6_C (15h)*. The value must be in the range [-127, +127].

9.59 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 159. 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 160. Z_OFS_USR register description

Z_OFS_USR_[7:0]	Accelerometer Z-axis user offset calibration expressed in 2's complement, weight depends on USR_OFF_W in *CTRL6_C (15h)*. The value must be in the range [-127, +127].

9.60 FIFO_DATA_OUT_TAG (78h)

FIFO tag register (r)

Table 161. 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	TAG_ PARITY

Table 162. 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 163: FIFO tag*
TAG_CNT_[1:0]	2-bit counter which identifies sensor time slot
TAG_PARITY	Parity check of TAG content

Table 163. FIFO tag

TAG_SENSOR_[4:0]	Sensor name
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
0x19	Sensor Hub Nack

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

FIFO data output X (r)

Table 164. 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 165. FIFO_DATA_OUT_X_H and FIFO_DATA_OUT_X_L register description

D[15:0]	FIFO X-axis output

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

FIFO data output Y (r)

Table 166. 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 167. FIFO_DATA_OUT_Y_H and FIFO_DATA_OUT_Y_L register description

D[15:0]	FIFO Y-axis output

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

FIFO data output Z (r)

Table 168. 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 169. FIFO_DATA_OUT_Z_H and FIFO_DATA_OUT_Z_L register description

D[15:0]	FIFO Z-axis output

Table 170. SPI_INT_OIS register

INT2_ DRDY_ OIS	LVL2_OIS	DEN_LH_ OIS	-	-	0	ST1_XL_ OIS	ST0_XL_ OIS

10 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 FUNC_CFG_EN is set to '1' in *FUNC_CFG_ACCESS (01h)*.

Table 171. Register address map - embedded functions

Name	Type	Register address		Default	Comment
		Hex	Binary		
PAGE_SEL	r/w	02	00000010	00000001	
ADV_PEDO	r/w	03	00000011	00000010	
EMB_FUNC_EN_A	r/w	04	00000100	00000000	
EMB_FUNC_EN_B	r/w	05	00000101	00000000	
PAGE_ADDRESS	r/w	08	00001000	00000000	
PAGE_VALUE	r/w	09	00001001	00000000	
EMB_FUNC_INT1	r/w	0A	00001010	00000000	
FSM_INT1_A	r/w	0B	00001011	00000000	
FSM_INT1_B	r/w	0C	00001100	00000000	
MLC_INT1	r/w	0D	00001101	00000000	
EMB_FUNC_INT2	r/w	0E	00001110	00000000	
FSM_INT2_A	r/w	0F	00001111	00000000	
FSM_INT2_B	r/w	10	00010000	00000000	
MLC_INT2	r/w	11	00010001	00000000	
EMB_FUNC_STATUS	r	12	00010010	output	
FSM_STATUS_A	r	13	00010011	output	
FSM_STATUS_B	r	14	00010100	output	
MLC_STATUS	r	15	00010101	output	
PAGE_RW	r/w	17	00010111	00000000	
RESERVED		18-43	00011000		
EMB_FUNC_FIFO_CFG	r/w	44	01000100	00000000	
FSM_ENABLE_A	r/w	46	01000110	00000000	
FSM_ENABLE_B	r/w	47	01000111	00000000	
FSM_LONG_COUNTER_L	r/w	48	01001000	00000000	
FSM_LONG_COUNTER_H	r/w	49	01001001	00000000	
FSM_LONG_COUNTER_CLEAR	r/w	4A	01001010	00000000	
FSM_OUTS1	r	4C	01001100	output	
FSM_OUTS2	r	4D	01001101	output	

Table 171. Register address map - embedded functions (continued)

Name	Type	Register address		Default	Comment
		Hex	Binary		
FSM_OUTS3	r	4E	01001110	output	
FSM_OUTS4	r	4F	01001111	output	
FSM_OUTS5	r	50	01010000	output	
FSM_OUTS6	r	51	01010001	output	
FSM_OUTS7	r	52	01010010	output	
FSM_OUTS8	r	53	01010011	output	
FSM_OUTS9	r	54	01010100	output	
FSM_OUTS10	r	55	01010101	output	
FSM_OUTS11	r	56	01010110	output	
FSM_OUTS12	r	57	01010111	output	
FSM_OUTS13	r	58	01011000	output	
FSM_OUTS14	r	59	01011001	output	
FSM_OUTS15	r	5A	01011010	output	
FSM_OUTS16	r	5B	01011011	output	
RESERVED		5E	01011110		
EMB_FUNC_ODR_CFG_B	r/w	5F	01011111	01001011	
EMB_FUNC_ODR_CFG_C	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	
MLC0_SRC	r	70	01110000	output	
MLC1_SRC	r	71	01110001	output	
MLC2_SRC	r	72	01110010	output	
MLC3_SRC	r	73	01110011	output	
MLC4_SRC	r	74	01110100	output	
MLC5_SRC	r	75	01110101	output	
MLC6_SRC	r	76	01110110	output	
MLC7_SRC	r	77	01110111	output	

Registers marked as *Reserved* 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.

11 Embedded functions register description

11.1 PAGE_SEL (02h)

Enable advanced features dedicated page (r/w)

Table 172. 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 173. PAGE_SEL register description

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

11.2 ADV_PEDO (03h)

Enable/disable pedometer advanced features register (r/w)

Table 174. PAGE_SEL register

0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	PEDO_FPR _ADF_DIS	0(1)

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

Table 175. PAGE_SEL register description

PEDO_FPR _ADF_DIS	Disable pedometer false-positive rejection block and advanced detection feature block. Default value: 1 (0: Pedometer false-positive rejection block and advanced detection feature block enabled; 1: Pedometer false-positive rejection block and advanced detection feature block disabled)

11.3 EMB_FUNC_EN_A (04h)

Embedded functions enable register (r/w)

Table 176. EMB_FUNC_EN_A register

0(1)	0(1)	SIGN_ MOTION_ EN	TILT_EN	PEDO_EN	0(1)	0(1)	0(1)

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

Table 177. EMB_FUNC_EN_A register description

SIGN_MOTION_EN	Enable significant motion detection function. Default value: 0 (0: significant motion detection function disabled; 1: significant motion detection function enabled)
TILT_EN	Enable tilt calculation. Default value: 0 (0: tilt algorithm disabled; 1: tilt algorithm enabled)
PEDO_EN	Enable pedometer algorithm. Default value: 0 (0: pedometer algorithm disabled; 1: pedometer algorithm enabled)

11.4 EMB_FUNC_EN_B (05h)

Embedded functions enable register (r/w)

Table 178. 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 179. EMB_FUNC_EN_B register description

MLC_EN	Enable Machine Learning Core feature. Default value: 0 (0: Machine Learning Core feature disabled; 1: Machine Learning Core feature enabled)
FIFO_COMPR_EN(1)	Enable FIFO compression feature. Default value: 0 (0: FIFO compression feature disabled; 1: FIFO compression feature enabled)
FSM_EN	Enable Finite State Machine (FSM) feature. Default value: 0 (0: FSM feature disabled; 1: FSM feature enabled)

1. This bit is effective if the FIFO_COMPR_RT_EN bit of *FIFO_CTRL2 (08h)* is set to 1.

11.5 PAGE_ADDRESS (08h)

Page address register (r/w)

Table 180. PAGE_ADDRESS register

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

Table 181. 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)*.

11.6 PAGE_VALUE (09h)

Page value register (r/w)

Table 182. PAGE_VALUE register

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

Table 183. 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.

11.7 EMB_FUNC_INT1 (0Ah)

INT1 pin control register (r/w)

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

Table 184. 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 185. EMB_FUNC_INT1 register description

INT1_FSM_LC(1)	Routing of FSM long counter timeout interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_SIG_MOT(1)	Routing of significant motion event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_TILT(1)	Routing of tilt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_STEP_ DETECTOR(1)	Routing of pedometer step recognition event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)

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

11.8 FSM_INT1_A (0Bh)

INT1 pin control register (r/w).

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

Table 186. FSM_INT1_A register

INT1_ FSM8	INT1_ FSM7	INT1_ FSM6	INT1_ FSM5	INT1_ FSM4	INT1_ FSM3	INT1_ FSM2	INT1_ FSM1

Table 187. FSM_INT1_A register description

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

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

11.9 FSM_INT1_B (0Ch)

INT1 pin control register (r/w).

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

Table 188. FSM_INT1_B register

INT1_ FSM16	INT1_ FSM15	INT1_ FSM14	INT1_ FSM13	INT1_ FSM12	INT1_ FSM11	INT1_ FSM10	INT1_ FSM9

Table 189. FSM_INT1_B register description

INT1_FSM16(1)	Routing of FSM16 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_FSM15(1)	Routing of FSM15 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_FSM14(1)	Routing of FSM14 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_FSM13(1)	Routing of FSM13 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_FSM12(1)	Routing of FSM12 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_FSM11(1)	Routing of FSM11 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_FSM10(1)	Routing of FSM10 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_FSM9(1)	Routing of FSM9 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)

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

11.10 MLC_INT1 (0Dh)

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

Table 190. MLC_INT1 register

INT1_ MLC8	INT1_ MLC7	INT1_ MLC6	INT1_ MLC5	INT1_ MLC4	INT1_ MLC3	INT1_ MLC2	INT1_ MLC1

Table 191. MLC_INT1 register description

INT1_MLC8	Routing of MLC8 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_MLC7	Routing of MLC7 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_MLC6	Routing of MLC6 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_MLC5	Routing of MLC5 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_MLC4	Routing of MLC4 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_MLC3	Routing of MLC3 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_MLC2	Routing of MLC2 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)
INT1_MLC1	Routing of MLC1 interrupt event on INT1. Default value: 0 (0: routing on INT1 disabled; 1: routing on INT1 enabled)

11.11 EMB_FUNC_INT2 (0Eh)

INT2 pin control register (r/w).

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

Table 192. 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 193. EMB_FUNC_INT2 register description

INT2_FSM_LC(1)	Routing of FSM long counter timeout interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_SIG_MOT(1)	Routing of significant motion event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_TILT(1)	Routing of tilt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_STEP_ DETECTOR(1)	Routing of pedometer step recognition event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)

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

11.12 FSM_INT2_A (0Fh)

INT2 pin control register (r/w).

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

Table 194. FSM_INT2_A register

INT2_ FSM8	INT2_ FSM7	INT2_ FSM6	INT2_ FSM5	INT2_ FSM4	INT2_ FSM3	INT2_ FSM2	INT2_ FSM1

Table 195. FSM_INT2_A register description

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

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

11.13 FSM_INT2_B (10h)

INT2 pin control register (r/w).

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

Table 196. FSM_INT2_B register

INT2_ FSM16	INT2_ FSM15	INT2_ FSM14	INT2_ FSM13	INT2_ FSM12	INT2_ FSM11	INT2_ FSM10	INT2_ FSM9

Table 197. FSM_INT2_B register description

INT2_FSM16(1)	Routing of FSM16 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_FSM15(1)	Routing of FSM15 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_FSM14(1)	Routing of FSM14 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_FSM13(1)	Routing of FSM13 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_FSM12(1)	Routing of FSM12 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_FSM11(1)	Routing of FSM11 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_FSM10(1)	Routing of FSM10 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_FSM9(1)	Routing of FSM9 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)

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

11.14 MLC_INT2 (11h)

INT2 pin control register (r/w).

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

Table 198. MLC_INT2 register

INT2_ MLC8	INT2_ MLC7	INT2_ MLC6	INT2_ MLC5	INT2_ MLC4	INT2_ MLC3	INT2_ MLC2	INT2_ MLC1

Table 199. MLC_INT2 register description

INT2_MLC8	Routing of MLC8 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_MLC7	Routing of MLC7 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_MLC6	Routing of MLC6 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_MLC5	Routing of MLC5 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_MLC4	Routing of MLC4 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_MLC3	Routing of MLC3 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_MLC2	Routing of MLC2 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)
INT2_MLC1	Routing of MLC1 interrupt event on INT2. Default value: 0 (0: routing on INT2 disabled; 1: routing on INT2 enabled)

11.15 EMB_FUNC_STATUS (12h)

Embedded function status register (r).

Table 200. EMB_FUNC_STATUS register

IS_FSM_LC	0	IS_ SIGMOT	IS_ TILT	IS_STEP_ DET	0	0	0

Table 201. 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)

11.16 FSM_STATUS_A (13h)

Finite State Machine status register (r).

Table 202. FSM_STATUS_A register

IS_FSM8	IS_FSM7	IS_FSM6	IS_FSM5	IS_FSM4	IS_FSM3	IS_FSM2	IS_FSM1

Table 203. FSM_STATUS_A 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)

11.17 FSM_STATUS_B (14h)

Finite State Machine status register (r).

Table 204. FSM_STATUS_B register

IS_FSM16	IS_FSM15	IS_FSM14	IS_FSM13	IS_FSM12	IS_FSM11	IS_FSM10	IS_FSM9

Table 205. FSM_STATUS_B register description

IS_FSM16	Interrupt status bit for FSM16 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM15	Interrupt status bit for FSM15 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM14	Interrupt status bit for FSM14 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM13	Interrupt status bit for FSM13 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM12	Interrupt status bit for FSM12 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM11	Interrupt status bit for FSM11 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM10	Interrupt status bit for FSM10 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_FSM9	Interrupt status bit for FSM9 interrupt event. (1: interrupt detected; 0: no interrupt)

11.18 MLC_STATUS (15h)

Machine Learning Core status register (r).

Table 206. MLC_STATUS register

IS_MLC8	IS_MLC7	IS_MLC6	IS_MLC5	IS_MLC4	IS_MLC3	IS_MLC2	IS_MLC1

Table 207. MLC_STATUS register description

IS_MLC8	Interrupt status bit for MLC8 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_MLC7	Interrupt status bit for MLC7 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_MLC6	Interrupt status bit for MLC6 interrupt event. (1: interrupt detected; 0: no interrupt)
IS_MLC5	Interrupt status bit for MLC5 interrupt event. (1: interrupt detected; 0: no interrupt)
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)

11.19 PAGE_RW (17h)

Enable read and write mode of advanced features dedicated page (r/w)

Table 208. 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 209. 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	Enable writes to the selected advanced features dedicated page(1). Default value: 0 (1: enable; 0: disable)
PAGE_READ	Enable 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.

11.20 EMB_FUNC_FIFO_CFG (44h)

Embedded functions batching configuration register (r/w).

Table 210. EMB_FUNC_FIFO_CFG register

0(1)	PEDO_ FIFO_EN	0(1)	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 211. EMB_FUNC_FIFO_CFG register description

PEDO_FIFO_EN	Enable FIFO batching of step counter values. Default value: 0

11.21 FSM_ENABLE_A (46h)

FSM enable register (r/w).

Table 212. FSM_ENABLE_A register

FSM8_EN	FSM7_EN	FSM6_EN	FSM5_EN	FSM4_EN	FSM3_EN	FSM2_EN	FSM1_EN

Table 213. FSM_ENABLE_A register description

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

11.22 FSM_ENABLE_B (47h)

FSM enable register (r/w).

Table 214. FSM_ENABLE_B register

FSM16_EN	FSM15_EN	FSM14_EN	FSM13_EN	FSM12_EN	FSM11_EN	FSM10_EN	FSM9_EN

Table 215. FSM_ENABLE_B register description

FSM16_EN	FSM16 enable. Default value: 0 (0: FSM16 disabled; 1: FSM16 enabled)
FSM15_EN	FSM15 enable. Default value: 0 (0: FSM15 disabled; 1: FSM15 enabled)
FSM14_EN	FSM14 enable. Default value: 0 (0: FSM14 disabled; 1: FSM14 enabled)
FSM13_EN	FSM13 enable. Default value: 0 (0: FSM13 disabled; 1: FSM13 enabled)
FSM12_EN	FSM12 enable. Default value: 0 (0: FSM12 disabled; 1: FSM12 enabled)
FSM11_EN	FSM11 enable. Default value: 0 (0: FSM11 disabled; 1: FSM11 enabled)
FSM10_EN	FSM10 enable. Default value: 0 (0: FSM10 disabled; 1: FSM10 enabled)
FSM9_EN	FSM9 enable. Default value: 0 (0: FSM9 disabled; 1: FSM9 enabled)

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

FSM long counter status register (r/w).

Long counter value is an unsigned integer value (16-bit format); this value can be reset using the LC_CLEAR bit in *FSM_LONG_COUNTER_CLEAR (4Ah)* register.

Table 216. 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 217. FSM_LONG_COUNTER_L register description

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

Table 218. 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 219. FSM_LONG_COUNTER_H register description

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

11.24 FSM_LONG_COUNTER_CLEAR (4Ah)

FSM long counter reset register (r/w).

Table 220. FSM_LONG_COUNTER_CLEAR register

0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	FSM_LC_ CLEARED	FSM_LC_ CLEAR

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

Table 221. FSM_LONG_COUNTER_CLEAR register description

FSM_LC_ CLEARED	This read-only bit is automatically set to 1 when the long counter reset is done. Default value: 0
FSM_LC_CLEAR	Clear FSM long counter value. Default value: 0

11.25 FSM_OUTS1 (4Ch)

FSM1 output register (r).

Table 222. FSM_OUTS1 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 223. 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)

11.26 FSM_OUTS2 (4Dh)

FSM2 output register (r).

Table 224. FSM_OUTS2 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 225. 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)

11.27 FSM_OUTS3 (4Eh)

FSM3 output register (r).

Table 226. FSM_OUTS3 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 227. 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)

11.28 FSM_OUTS4 (4Fh)

FSM4 output register (r).

Table 228. FSM_OUTS4 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 229. 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)

11.29 FSM_OUTS5 (50h)

FSM5 output register (r).

Table 230. FSM_OUTS5 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 231. 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)

11.30 FSM_OUTS6 (51h)

FSM6 output register (r).

Table 232. FSM_OUTS6 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 233. 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)

11.31 FSM_OUTS7 (52h)

FSM7 output register (r).

Table 234. FSM_OUTS7 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 235. 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)

11.32 FSM_OUTS8 (53h)

FSM8 output register (r).

Table 236. FSM_OUTS8 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 237. 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)

11.33 FSM_OUTS9 (54h)

FSM9 output register (r).

Table 238. FSM_OUTS9 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 239. FSM_OUTS9 register description

P_X	FSM9 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM9 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM9 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM9 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM9 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM9 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM9 output: positive event detected on the vector. (0: event not detected; 1: event detected
N_V	FSM9 output: negative event detected on the vector. (0: event not detected; 1: event detected)

11.34 FSM_OUTS10 (55h)

FSM10 output register (r).

Table 240. FSM_OUTS10 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 241. FSM_OUTS10 register description

P_X	FSM10 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM10 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM10 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM10 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM10 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM10 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM10 output: positive event detected on the vector. (0: event not detected; 1: event detected
N_V	FSM10 output: negative event detected on the vector. (0: event not detected; 1: event detected)

11.35 FSM_OUTS11 (56h)

FSM11 output register (r).

Table 242. FSM_OUTS11 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 243. FSM_OUTS11 register description

P_X	FSM11 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM11 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM11 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM11 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM11 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM11 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM11 output: positive event detected on the vector. (0: event not detected; 1: event detected
N_V	FSM11 output: negative event detected on the vector. (0: event not detected; 1: event detected)

11.36 FSM_OUTS12 (57h)

FSM12 output register (r).

Table 244. FSM_OUTS12 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 245. FSM_OUTS12 register description

P_X	FSM12 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM12 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM12 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM12 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM12 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM12 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM12 output: positive event detected on the vector. (0: event not detected; 1: event detected
N_V	FSM12 output: negative event detected on the vector. (0: event not detected; 1: event detected)

11.37 FSM_OUTS13 (58h)

FSM13 output register (r).

Table 246. FSM_OUTS13 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 247. FSM_OUTS13 register description

P_X	FSM13 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM13 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM13 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM13 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM13 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM13 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM13 output: positive event detected on the vector. (0: event not detected; 1: event detected
N_V	FSM13 output: negative event detected on the vector. (0: event not detected; 1: event detected)

11.38 FSM_OUTS14 (59h)

FSM14 output register (r).

Table 248. FSM_OUTS14 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 249. FSM_OUTS14 register description

P_X	FSM14 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM14 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM14 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM14 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM14 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM14 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM14 output: positive event detected on the vector. (0: event not detected; 1: event detected
N_V	FSM14 output: negative event detected on the vector. (0: event not detected; 1: event detected)

11.39 FSM_OUTS15 (5Ah)

FSM15 output register (r).

Table 250. FSM_OUTS15 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 251. FSM_OUTS15 register description

P_X	FSM15 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM15 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM15 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM15 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM15 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM15 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM15 output: positive event detected on the vector. (0: event not detected; 1: event detected
N_V	FSM15 output: negative event detected on the vector. (0: event not detected; 1: event detected)

11.40 FSM_OUTS16 (5Bh)

FSM16 output register (r).

Table 252. FSM_OUTS16 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V

Table 253. FSM_OUTS16 register description

P_X	FSM16 output: positive event detected on the X-axis. (0: event not detected; 1: event detected)
N_X	FSM16 output: negative event detected on the X-axis. (0: event not detected; 1: event detected)
P_Y	FSM16 output: positive event detected on the Y-axis. (0: event not detected; 1: event detected)
N_Y	FSM16 output: negative event detected on the Y-axis. (0: event not detected; 1: event detected)
P_Z	FSM16 output: positive event detected on the Z-axis. (0: event not detected; 1: event detected)
N_Z	FSM16 output: negative event detected on the Z-axis. (0: event not detected; 1: event detected)
P_V	FSM16 output: positive event detected on the vector. (0: event not detected; 1: event detected
N_V	FSM16 output: negative event detected on the vector. (0: event not detected; 1: event detected)

11.41 EMB_FUNC_ODR_CFG_B (5Fh)

Finite State Machine output data rate configuration register (r/w).

Table 254. EMB_FUNC_ODR_CFG_B register

0(1)	1(2)	0(1)	FSM_ ODR1	FSM_ ODR0	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 255. EMB_FUNC_ODR_CFG_B register description

FSM_ODR[1:0]	Finite State Machine ODR configuration: (00: 12.5 Hz; 01: 26 Hz (default); 10: 52 Hz; 11: 104 Hz)

11.42 EMB_FUNC_ODR_CFG_C (60h)

Machine Learning Core output data rate configuration register (r/w).

Table 256. EMB_FUNC_ODR_CFG_C register

0(1)	0(1)	MLC_ODR1	MLC_ODR0	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 257. EMB_FUNC_ODR_CFG_C register description

MLC_ODR[1:0]	Machine Learning Core ODR configuration: (00: 12.5 Hz; 01: 26 Hz (default); 10: 52 Hz; 11: 104 Hz)

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

Step counter output register (r).

Table 258. STEP_COUNTER_L register

STEP_7	STEP_6	STEP_5	STEP_4	STEP_3	STEP_2	STEP_1	STEP_0

Table 259. STEP_COUNTER_L register description

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

Table 260. STEP_COUNTER_H register

STEP_15	STEP_14	STEP_13	STEP_12	STEP_11	STEP_10	STEP_9	STEP_8

Table 261. STEP_COUNTER_H register description

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

11.44 EMB_FUNC_SRC (64h)

Embedded function source register (r/w)

Table 262. EMB_FUNC_SRC register

PEDO_ RST_ STEP	0	STEP_ DETECTED	STEP_ COUNT_ DELTA_IA	STEP_ OVERFLOW	STEPCOU NTER_BIT _SET	0	0

Table 263. 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. Read-only bit.

11.45 EMB_FUNC_INIT_A (66h)

Embedded functions initialization register (r/w)

Table 264. EMB_FUNC_INIT_A register

0(1)	0(1)	SIG_MOT _INIT	TILT _INIT	STEP_DET _INIT	0(1)	0(1)	0(1)

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

Table 265. EMB_FUNC_INIT_A register description

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

11.46 EMB_FUNC_INIT_B (67h)

Embedded functions initialization register (r/w)

Table 266. EMB_FUNC_INIT_B register

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

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

Table 267. EMB_FUNC_INIT_B register description

MLC_INIT	Machine Learning Core initialization request. Default value: 0
FSM_INIT	FSM initialization request. Default value: 0

11.47 MLC0_SRC (70h)

Machine Learning Core source register (r)

Table 268. MLC0_SRC register

MLC0_ SRC_7	MLC0_ SRC_6	MLC0_ SRC_5	MLC0_ SRC_4	MLC0_ SRC_3	MLC0_ SRC_2	MLC0_ SRC_1	MLC0_ SRC_0

Table 269. MLC0_SRC register description

MLC0_SRC_[7:0]	Output value of MLC0 decision tree

11.48 MLC1_SRC (71h)

Machine Learning Core source register (r)

Table 270. 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 271. MLC1_SRC register description

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

11.49 MLC2_SRC (72h)

Machine Learning Core source register (r)

Table 272. MLC2_SRC register

MLC2_SRC_7	MLC2_SRC_6	MLC2_SRC_5	MLC2_SRC_4	MLC2_SRC_3	MLC2_SRC_2	MLC2_SRC_1	MLC2_SRC_0

Table 273. MLC2_SRC register description

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

11.50 MLC3_SRC (73h)

Machine Learning Core source register (r)

Table 274. 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 275. MLC3_SRC register description

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

11.51 MLC4_SRC (74h)

Machine Learning Core source register (r)

Table 276. 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 277. MLC4_SRC register description

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

11.52 MLC5_SRC (75h)

Machine Learning Core source register (r)

Table 278. MLC5_SRC register

MLC5_SRC_7	MLC5_SRC_6	MLC5_SRC_5	MLC5_SRC_4	MLC5_SRC_3	MLC5_SRC_2	MLC5_SRC_1	MLC5_SRC_0

Table 279. MLC5_SRC register description

MLC5_SRC_[7:0]	Output value of MLC5 decision tree

11.53 MLC6_SRC (76h)

Machine Learning Core source register (r)

Table 280. MLC6_SRC register

MLC6_SRC_7	MLC6_SRC_6	MLC6_SRC_5	MLC6_SRC_4	MLC6_SRC_3	MLC6_SRC_2	MLC6_SRC_1	MLC6_SRC_0

Table 281. MLC6_SRC register description

MLC6_SRC_[7:0]	Output value of MLC6 decision tree

11.54 MLC7_SRC (77h)

Machine Learning Core source register (r)

Table 282. MLC7_SRC register

MLC7_SRC_7	MLC7_SRC_6	MLC7_SRC_5	MLC7_SRC_4	MLC7_SRC_3	MLC7_SRC_2	MLC7_SRC_1	MLC7_SRC_0

Table 283. MLC7_SRC register description

MLC7_SRC_[7:0]	Output value of MLC7 decision tree

12 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)*.

Table 284. Register address map - embedded advanced features page 0

Name	Type	Register address		Default	Comment
		Hex	Binary		
MAG_SENSITIVITY_L	r/w	BA	10111010	00100100	
MAG_SENSITIVITY_H	r/w	BB	10111011	00010110	
MAG_OFFX_L	r/w	C0	11000000	00000000	
MAG_OFFX_H	r/w	C1	11000001	00000000	
MAG_OFFY_L	r/w	C2	11000010	00000000	
MAG_OFFY_H	r/w	C3	11000011	00000000	
MAG_OFFZ_L	r/w	C4	11000100	00000000	
MAG_OFFZ_H	r/w	C5	11000101	00000000	
MAG_SI_XX_L	r/w	C6	11000110	00000000	
MAG_SI_XX_H	r/w	C7	11000111	00111100	
MAG_SI_XY_L	r/w	C8	11001000	00000000	
MAG_SI_XY_H	r/w	C9	11001001	00000000	
MAG_SI_XZ_L	r/w	CA	11001010	00000000	
MAG_SI_XZ_H	r/w	CB	11001011	00000000	
MAG_SI_YY_L	r/w	CC	11001100	00000000	
MAG_SI_YY_H	r/w	CD	11001101	00111100	
MAG_SI_YZ_L	r/w	CE	11001110	00000000	
MAG_SI_YZ_H	r/w	CF	11001111	00000000	
MAG_SI_ZZ_L	r/w	D0	11010000	00000000	
MAG_SI_ZZ_H	r/w	D1	11010001	00111100	
MAG_CFG_A	r/w	D4	11010100	00000101	
MAG_CFG_B	r/w	D5	11010101	00000010	

The table given below 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 285. 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_MAG_SENSITIVITY_L	r/w	E8	11101000	00000000	
MLC_MAG_SENSITIVITY_H	r/w	E9	11101001	00111100	

Registers marked as *Reserved* 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:

Example: write value 06h register at address 84h (PEDO_DEB_STEPS_CONF) in Page 1

1. Write bit FUNC_CFG_EN = 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 FUNC_CFG_EN = 0 in FUNC_CFG_ACCESS (01h) // Disable access to embedded functions registers

Read procedure example:

Example: read value of register at address 84h (PEDO_DEB_STEPS_CONF) in Page 1

1. Write bit FUNC_CFG_EN = 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 FUNC_CFG_EN = 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.

13 Embedded advanced features register description

13.1 Page 0 - Embedded advanced features registers

13.1.1 MAG_SENSITIVITY_L (BAh) and MAG_SENSITIVITY_H (BBh)

External magnetometer sensitivity value register for the Finite State Machine (r/w).

This register corresponds to the LSB-to-gauss conversion value of the external magnetometer 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 MAG_SENS[15:0] is 0x1624, corresponding to 0.0015 gauss/LSB.

Table 286. MAG_SENSITIVITY_L register

MAG_ SENS_7	MAG_ SENS_6	MAG_ SENS_5	MAG_ SENS_4	MAG_ SENS_3	MAG_ SENS_2	MAG_ SENS_1	MAG_ SENS_0

Table 287. MAG_SENSITIVITY_L register description

MAG_SENS_[7:0]	External magnetometer sensitivity (LSbyte). Default value: 00100100

Table 288. MAG_SENSITIVITY_H register

MAG_ SENS_15	MAG_ SENS_14	MAG_ SENS_13	MAG_ SENS_12	MAG_ SENS_11	MAG_ SENS_10	MAG_ SENS_9	MAG_ SENS_8

Table 289. MAG_SENSITIVITY_H register description

MAG_SENS_[15:8]	External magnetometer sensitivity (MSbyte). Default value: 00010110

13.1.2 MAG_OFFX_L (C0h) and MAG_OFFX_H (C1h)

Offset for X-axis hard-iron compensation 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 290. MAG_OFFX_L register

MAG_OFF X_7	MAG_OFF X_6	MAG_OFF X_5	MAG_OFF X_4	MAG_OFF X_3	MAG_OFF X_2	MAG_OFF X_1	MAG_OFF X_0

Table 291. MAG_OFFX_L register description

MAG_OFFX_[7:0]	Offset for X-axis hard-iron compensation (LSbyte). Default value: 00000000

Table 292. MAG_OFFX_H register

MAG_OFF X_15	MAG_OFF X_14	MAG_OFF X_13	MAG_OFF X_12	MAG_OFF X_11	MAG_OFF X_10	MAG_OFF X_9	MAG_OFF X_8

Table 293. MAG_OFFX_H register description

MAG_OFFX_[15:8]	Offset for X-axis hard-iron compensation (MSbyte). Default value: 00000000

13.1.3 MAG_OFFY_L (C2h) and MAG_OFFY_H (C3h)

Offset for Y-axis hard-iron compensation 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 294. MAG_OFFY_L register

MAG_OFFY_7	MAG_OFFY_6	MAG_OFFY_5	MAG_OFFY_4	MAG_OFFY_3	MAG_OFFY_2	MAG_OFFY_1	MAG_OFFY_0

Table 295. MAG_OFFY_L register description

MAG_OFFY_[7:0]	Offset for Y-axis hard-iron compensation (LSbyte). Default value: 00000000

Table 296. MAG_OFFY_H register

MAG_OFFY_15	MAG_OFFY_14	MAG_OFFY_13	MAG_OFFY_12	MAG_OFFY_11	MAG_OFFY_10	MAG_OFFY_9	MAG_OFFY_8

Table 297. MAG_OFFY_H register description

MAG_OFFY_[15:8]	Offset for Y-axis hard-iron compensation (MSbyte). Default value: 00000000

13.1.4 MAG_OFFZ_L (C4h) and MAG_OFFZ_H (C5h)

Offset for Z-axis hard-iron compensation 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 298. MAG_OFFZ_L register

MAG_OFFZ_7	MAG_OFFZ_6	MAG_OFFZ_5	MAG_OFFZ_4	MAG_OFFZ_3	MAG_OFFZ_2	MAG_OFFZ_1	MAG_OFFZ_0

Table 299. MAG_OFFZ_L register description

MAG_OFFZ_[7:0]	Offset for Z-axis hard-iron compensation (LSbyte). Default value: 00000000

Table 300. MAG_OFFZ_H register

MAG_OFFZ_15	MAG_OFFZ_14	MAG_OFFZ_13	MAG_OFFZ_12	MAG_OFFZ_11	MAG_OFFZ_10	MAG_OFFZ_9	MAG_OFFZ_8

Table 301. MAG_OFFZ_H register description

MAG_OFFZ_[15:8]	Offset for Z-axis hard-iron compensation (MSbyte). Default value: 00000000

13.1.5 MAG_SI_XX_L (C6h) and MAG_SI_XX_H (C7h)

Soft-iron (3x3 symmetric) matrix correction 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 302. MAG_SI_XX_L register

MAG_SI_XX_7	MAG_SI_XX_6	MAG_SI_XX_5	MAG_SI_XX_4	MAG_SI_XX_3	MAG_SI_XX_2	MAG_SI_XX_1	MAG_SI_XX_0

Table 303. MAG_SI_XX_L register description

MAG_SI_XX_[7:0]	Soft-iron correction row1 col1 coefficient (LSbyte). Default value: 00000000

Table 304. MAG_SI_XX_H register

MAG_SI_XX_15	MAG_SI_XX_14	MAG_SI_XX_13	MAG_SI_XX_12	MAG_SI_XX_11	MAG_SI_XX_10	MAG_SI_XX_9	MAG_SI_XX_8

Table 305. MAG_SI_XX_H register description

MAG_SI_XX_[15:8]	Soft-iron correction row1 col1 coefficient (MSbyte). Default value: 00111100

13.1.6 MAG_SI_XY_L (C8h) and MAG_SI_XY_H (C9h)

Soft-iron (3x3 symmetric) matrix correction 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 306. MAG_SI_XY_L register

MAG_SI_XY_7	MAG_SI_XY_6	MAG_SI_XY_5	MAG_SI_XY_4	MAG_SI_XY_3	MAG_SI_XY_2	MAG_SI_XY_1	MAG_SI_XY_0

Table 307. MAG_SI_XY_L register description

MAG_SI_XY_[7:0]	Soft-iron correction row1 col2 (and row2 col1) coefficient (LSbyte). Default value: 00000000

Table 308. MAG_SI_XY_H register

MAG_SI_XY_15	MAG_SI_XY_14	MAG_SI_XY_13	MAG_SI_XY_12	MAG_SI_XY_11	MAG_SI_XY_10	MAG_SI_XY_9	MAG_SI_XY_8

Table 309. MAG_SI_XY_H register description

MAG_SI_XY_[15:8]	Soft-iron correction row1 col2 (and row2 col1) coefficient (MSbyte). Default value: 00000000

13.1.7 MAG_SI_XZ_L (CAh) and MAG_SI_XZ_H (CBh)

Soft-iron (3x3 symmetric) matrix correction 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 310. MAG_SI_XZ_L register

MAG_SI_XZ_7	MAG_SI_XZ_6	MAG_SI_XZ_5	MAG_SI_XZ_4	MAG_SI_XZ_3	MAG_SI_XZ_2	MAG_SI_XZ_1	MAG_SI_XZ_0

Table 311. MAG_SI_XZ_L register description

MAG_SI_XZ_[7:0]	Soft-iron correction row1 col3 (and row3 col1) coefficient (LSbyte). Default value: 00000000

Table 312. MAG_SI_XZ_H register

MAG_SI_XZ_15	MAG_SI_XZ_14	MAG_SI_XZ_13	MAG_SI_XZ_12	MAG_SI_XZ_11	MAG_SI_XZ_10	MAG_SI_XZ_9	MAG_SI_XZ_8

Table 313. MAG_SI_XZ_H register description

MAG_SI_XZ_[15:8]	Soft-iron correction row1 col3 (and row3 col1) coefficient (MSbyte). Default value: 00000000

13.1.8 MAG_SI_YY_L (CCh) and MAG_SI_YY_H (CDh)

Soft-iron (3x3 symmetric) matrix correction 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 314. MAG_SI_YY_L register

MAG_SI_YY_7	MAG_SI_YY_6	MAG_SI_YY_5	MAG_SI_YY_4	MAG_SI_YY_3	MAG_SI_YY_2	MAG_SI_YY_1	MAG_SI_YY_0

Table 315. MAG_SI_YY_L register description

MAG_SI_YY_[7:0]	Soft-iron correction row2 col2 coefficient (LSbyte). Default value: 00000000

Table 316. MAG_SI_YY_H register

MAG_SI_YY_15	MAG_SI_YY_14	MAG_SI_YY_13	MAG_SI_YY_12	MAG_SI_YY_11	MAG_SI_YY_10	MAG_SI_YY_9	MAG_SI_YY_8

Table 317. MAG_SI_YY_H register description

MAG_SI_YY_[15:8]	Soft-iron correction row2 col2 coefficient (MSbyte). Default value: 00111100

13.1.9 MAG_SI_YZ_L (CEh) and MAG_SI_YZ_H (CFh)

Soft-iron (3x3 symmetric) matrix correction 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 318. MAG_SI_YZ_L register

MAG_SI_YZ_7	MAG_SI_YZ_6	MAG_SI_YZ_5	MAG_SI_YZ_4	MAG_SI_YZ_3	MAG_SI_YZ_2	MAG_SI_YZ_1	MAG_SI_YZ_0

Table 319. MAG_SI_YZ_L register description

MAG_SI_YZ_[7:0]	Soft-iron correction row2 col3 (and row3 col2) coefficient (LSbyte). Default value: 00000000

Table 320. MAG_SI_YZ_H register

MAG_SI_YZ_15	MAG_SI_YZ_14	MAG_SI_YZ_13	MAG_SI_YZ_12	MAG_SI_YZ_11	MAG_SI_YZ_10	MAG_SI_YZ_9	MAG_SI_YZ_8

Table 321. MAG_SI_YZ_H register description

MAG_SI_YZ_[15:8]	Soft-iron correction row2 col3 (and row3 col2) coefficient (MSbyte). Default value: 00000000

13.1.10 MAG_SI_ZZ_L (D0h) and MAG_SI_ZZ_H (D1h)

Soft-iron (3x3 symmetric) matrix correction 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 322. MAG_SI_ZZ_L register

MAG_SI_ZZ_7	MAG_SI_ZZ_6	MAG_SI_ZZ_5	MAG_SI_ZZ_4	MAG_SI_ZZ_3	MAG_SI_ZZ_2	MAG_SI_ZZ_1	MAG_SI_ZZ_0

Table 323. MAG_SI_ZZ_L register description

MAG_SI_ZZ_[7:0]	Soft-iron correction row3 col3 coefficient (LSbyte). Default value: 00000000

Table 324. MAG_SI_ZZ_H register

MAG_SI_ZZ_15	MAG_SI_ZZ_14	MAG_SI_ZZ_13	MAG_SI_ZZ_12	MAG_SI_ZZ_11	MAG_SI_ZZ_10	MAG_SI_ZZ_9	MAG_SI_ZZ_8

Table 325. MAG_SI_ZZ_H register description

MAG_SI_ZZ_[15:8]	Soft-iron correction row3 col3 coefficient (MSbyte). Default value: 00111100

13.1.11 MAG_CFG_A (D4h)

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

Table 326. MAG_CFG_A register

0(1)	MAG_Y_AXIS2	MAG_Y_AXIS1	MAG_Y_AXIS0	0(1)	MAG_Z_AXIS2	MAG_Z_AXIS1	MAG_Z_AXIS0

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

Table 327. MAG_CFG_A description

MAG_Y_AXIS[2:0]	Magnetometer 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)
MAG_Z_AXIS[2:0]	Magnetometer 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)

13.1.12 MAG_CFG_B (D5h)

External magnetometer coordinates (X-axis) rotation register (r/w).

Table 328. MAG_CFG_B register

0(1)	0(1)	0(1)	0(1)	0(1)	MAG_X_AXIS2	MAG_X_AXIS1	MAG_X_AXIS0

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

Table 329. MAG_CFG_B description

MAG_X_AXIS[2:0]	Magnetometer 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)

13.2 Page 1 - Embedded advanced features registers

13.2.1 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 330. FSM_LC_TIMEOUT_L register

FSM_LC_TIMEOUT 7	FSM_LC_TIMEOUT 6	FSM_LC_TIMEOUT 5	FSM_LC_TIMEOUT 4	FSM_LC_TIMEOUT 3	FSM_LC_TIMEOUT 2	FSM_LC_TIMEOUT 1	FSM_LC_TIMEOUT 0

Table 331. FSM_LC_TIMEOUT_L register description

FSM_LC_TIMEOUT[7:0]	FSM long counter timeout value (LSbyte). Default value: 00000000

Table 332. FSM_LC_TIMEOUT_H register

FSM_LC_TIMEOUT 15	FSM_LC_TIMEOUT 14	FSM_LC_TIMEOUT 13	FSM_LC_TIMEOUT 12	FSM_LC_TIMEOUT 11	FSM_LC_TIMEOUT 10	FSM_LC_TIMEOUT 9	FSM_LC_TIMEOUT 8

Table 333. FSM_LC_TIMEOUT_H register description

FSM_LC_TIMEOUT[15:8]	FSM long counter timeout value (MSbyte). Default value: 00000000

13.2.2 FSM_PROGRAMS (7Ch)

FSM number of programs register (r/w).

Table 334. 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 335. FSM_PROGRAMS register description

FSM_N_PROG[7:0]	Number of FSM programs; must be less than or equal to 16. Default value: 00000000

13.2.3 FSM_START_ADD_L (7Eh) and FSM_START_ADD_H (7Fh)

FSM start address register (r/w). First available address is 0x033C.

Table 336. FSM_START_ADD_L register

FSM_START7	FSM_START6	FSM_START5	FSM_START4	FSM_START3	FSM_START2	FSM_START1	FSM_START0

Table 337. FSM_START_ADD_L register description

FSM_START[7:0]	FSM start address value (LSbyte). Default value: 00000000

Table 338. FSM_START_ADD_H register

FSM_START15	FSM_START14	FSM_START13	FSM_START12	FSM_START11	FSM_START10	FSM_START9	FSM_START8

Table 339. FSM_START_ADD_H register description

FSM_START[15:8]	FSM start address value (MSbyte). Default value: 00000000

13.2.4 PEDO_CMD_REG (83h)

Pedometer configuration register (r/w)

Table 340. PEDO_CMD_REG register

0(1)	0(1)	0(1)	0(1)	CARRY_COUNT_EN	FP_REJECTION_EN	0(1)	AD_DET_EN

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

Table 341. 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.
AD_DET_EN(2)	Enables the advanced detection feature.

1. This bit is effective if the MLC_EN bit of the *EMB_FUNC_EN_B (05h)* register is set to 1 and the PEDO_FPR_ADF_DIS bit of the *ADV_PEDO (03h)* register is set to 0.
2. This bit is effective if the FP_REJECTION_EN bit in PEDO_CMD_REG (83h) register is set to 1, the MLC_EN bit of the *EMB_FUNC_EN_B (05h)* register is set to 1 and the PEDO_FPR_ADF_DIS bit of the *ADV_PEDO (03h)* register is set to 0.

13.2.5 PEDO_DEB_STEPS_CONF (84h)

Pedometer debounce configuration register (r/w)

Table 342. PEDO_DEB_STEPS_CONF register

DEB_STEP7	DEB_STEP6	DEB_STEP5	DEB_STEP4	DEB_STEP3	DEB_STEP2	DEB_STEP1	DEB_STEP0

Table 343. 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

13.2.6 PEDO_SC_DELTAT_L (D0h) & PEDO_SC_DELTAT_H (D1h)

Time period register for step detection on delta time (r/w)

Table 344. 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 345. 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 346. PEDO_SC_DELTAT_H/L register description

PD_SC_[15:0]	Time period value (1LSB = 6.4 ms)

13.2.7 MLC_MAG_SENSITIVITY_L (E8h) and MLC_MAG_SENSITIVITY_H (E9h)

External magnetometer sensitivity value register for the Machine Learning Core (r/w).

This register corresponds to the LSB-to-gauss conversion value of the external magnetometer 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_MAG_S_[15:0] is 0x3C00, corresponding to 1 gauss/LSB.

Table 347. MLC_MAG_SENSITIVITY_L register

MLC_ MAG_S_7	MLC_ MAG_S_6	MLC_ MAG_S_5	MLC_ MAG_S_4	MLC_ MAG_S_3	MLC_ MAG_S_2	MLC_ MAG_S_1	MLC_ MAG_S_0

Table 348. MLC_ MAG_SENSITIVITY_L register description

MLC_MAG_S_[7:0]	External magnetometer sensitivity (LSbyte). Default value: 00000000

Table 349. MLC_MAG_SENSITIVITY_H register

MLC_ MAG_S_15	MLC_ MAG_S_14	MLC_ MAG_S_13	MLC_ MAG_S_12	MLC_ MAG_S_11	MLC_ MAG_S_10	MLC_ MAG_S_9	MLC_ MAG_S_8

Table 350. MLC_ MAG_SENSITIVITY_H register description

MLC_MAG_S_[15:8]	External magnetometer sensitivity (MSbyte). Default value: 00111100

14 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 351. 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	rw	14	00010100	00000000	
SLV0_ADD	rw	15	00010101	00000000	
SLV0_SUBADD	rw	16	00010110	00000000	
SLV0_CONFIG	rw	17	0001 0111	00000000	
SLV1_ADD	rw	18	00011000	00000000	
SLV1_SUBADD	rw	19	00011001	00000000	
SLV1_CONFIG	rw	1A	00011010	00000000	
SLV2_ADD	rw	1B	00011011	00000000	
SLV2_SUBADD	rw	1C	00011100	00000000	
SLV2_CONFIG	rw	1D	00011101	00000000	

Table 351. Register address map - sensor hub registers

Name	Type	Register address		Default	Comment
		Hex	Binary		
SLV3_ADD	rw	1E	00011110	00000000	
SLV3_SUBADD	rw	1F	00011111	00000000	
SLV3_CONFIG	rw	20	00100000	00000000	
DATAWRITE_SLV0	rw	21	00100001	00000000	
STATUS_MASTER	r	22	00100010	output	

Registers marked as Reserved 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.

15 Sensor hub register description

15.1 SENSOR_HUB_1 (02h)

Sensor hub output register (r)

First byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 352. 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 353. SENSOR_HUB_1 register description

SensorHub1[7:0]	First byte associated to external sensors

15.2 SENSOR_HUB_2 (03h)

Sensor hub output register (r)

Second byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 354. 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 355. SENSOR_HUB_2 register description

SensorHub2[7:0]	Second byte associated to external sensors

15.3 SENSOR_HUB_3 (04h)

Sensor hub output register (r)

Third byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 356. 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 357. SENSOR_HUB_3 register description

SensorHub3[7:0]	Third byte associated to external sensors

15.4 SENSOR_HUB_4 (05h)

Sensor hub output register (r)

Fourth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 358. 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 359. SENSOR_HUB_4 register description

SensorHub4[7:0]	Fourth byte associated to external sensors

15.5 SENSOR_HUB_5 (06h)

Sensor hub output register (r)

Fifth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 360. 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 361. SENSOR_HUB_5 register description

SensorHub5[7:0]	Fifth byte associated to external sensors

15.6 SENSOR_HUB_6 (07h)

Sensor hub output register (r)

Sixth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 362. 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 363. SENSOR_HUB_6 register description

SensorHub6[7:0]	Sixth byte associated to external sensors

15.7 SENSOR_HUB_7 (08h)

Sensor hub output register (r)

Seventh byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 364. 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 365. SENSOR_HUB_7 register description

SensorHub7[7:0]	Seventh byte associated to external sensors

15.8 SENSOR_HUB_8 (09h)

Sensor hub output register (r)

Eighth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 366. 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 367. SENSOR_HUB_8 register description

SensorHub8[7:0]	Eighth byte associated to external sensors

15.9 SENSOR_HUB_9 (0Ah)

Sensor hub output register (r)

Ninth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 368. 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 369. SENSOR_HUB_9 register description

SensorHub9[7:0]	Ninth byte associated to external sensors

15.10 SENSOR_HUB_10 (0Bh)

Sensor hub output register (r)

Tenth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 370. 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 371. SENSOR_HUB_10 register description

SensorHub10[7:0]	Tenth byte associated to external sensors

15.11 SENSOR_HUB_11 (0Ch)

Sensor hub output register (r)

Eleventh byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 372. 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 373. SENSOR_HUB_11 register description

SensorHub11[7:0]	Eleventh byte associated to external sensors

15.12 SENSOR_HUB_12 (0Dh)

Sensor hub output register (r)

Twelfth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 374. 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 375. SENSOR_HUB_12 register description

SensorHub12[7:0]	Twelfth byte associated to external sensors

15.13 SENSOR_HUB_13 (0Eh)

Sensor hub output register (r)

Thirteenth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 376. 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 377. SENSOR_HUB_13 register description

SensorHub13[7:0]	Thirteenth byte associated to external sensors

15.14 SENSOR_HUB_14 (0Fh)

Sensor hub output register (r)

Fourteenth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 378. 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 379. SENSOR_HUB_14 register description

SensorHub14[7:0]	Fourteenth byte associated to external sensors

15.15 SENSOR_HUB_15 (10h)

Sensor hub output register (r)

Fifteenth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 380. 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 381. SENSOR_HUB_15 register description

SensorHub15[7:0]	Fifteenth byte associated to external sensors

15.16 SENSOR_HUB_16 (11h)

Sensor hub output register (r)

Sixteenth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 382. 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 383. SENSOR_HUB_16 register description

SensorHub16[7:0]	Sixteenth byte associated to external sensors

15.17 SENSOR_HUB_17 (12h)

Sensor hub output register (r)

Seventeenth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 384. 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 385. SENSOR_HUB_17 register description

SensorHub17[7:0]	Seventeenth byte associated to external sensors

15.18 SENSOR_HUB_18 (13h)

Sensor hub output register (r)

Eighteenth byte associated to external sensors. The content of the register is consistent with the SLAVEx_CONFIG number of read operation configurations (for external sensors from x = 0 to x = 3).

Table 386. 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 387. SENSOR_HUB_17 register description

SensorHub18[7:0]	Eighteenth byte associated to external sensors

15.19 MASTER_CONFIG (14h)

Master configuration register (r/w)

Table 388. MASTER_CONFIG register

RST_ MASTER_ REGS	WRITE_ ONCE	START_ CONFIG	PASS_ THROUGH _MODE	SHUB_ PU_EN	MASTER_ ON	AUX_ SENS_ ON1	AUX_ SENS_ ON0

Table 389. MASTER_CONFIG register description

RST_MASTER_ REGS	Reset Master logic and output registers. Must be set to '1' and then set it 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, main I²C line is short-circuited with the auxiliary line)
SHUB_PU_EN	Master I²C pull-up enable. Default value: 0 (0: internal pull-up on auxiliary I²C line disabled; 1: internal pull-up on auxiliary I²C line enabled)
MASTER_ON	Sensor hub I^2C master enable. Default: 0 (0: master I^2C of sensor hub disabled; 1: master I^2C 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)

15.20 SLV0_ADD (15h)

I^2C slave address of the first external sensor (Sensor 1) register (r/w).

Table 390. SLV0_ADD register

slave0_ add6	slave0_ add5	slave0_ add4	slave0_ add3	slave0_ add2	slave0_ add1	slave0_ add0	rw_0

Table 391. SLV_ADD register description

slave0_add[6:0]	I^2C slave address of Sensor1 that can be read by the sensor hub. Default value: 0000000
rw_0	Read/write operation on Sensor 1. Default value: 0 (0: write operation; 1: read operation)

15.21 SLV0_SUBADD (16h)

Address of register on the first external sensor (Sensor 1) register (r/w).

Table 392. SLV0_SUBADD register

slave0_ reg7	slave0_ reg6	slave0_ reg5	slave0_ reg4	slave0_ reg3	slave0_ reg2	slave0_ reg1	slave0_ reg0

Table 393. SLV0_SUBADD register description

slave0_reg[7:0]	Address of register on Sensor1 that has to be read/written according to the rw_0 bit value in *SLV0_ADD (15h)*. Default value: 00000000

15.22 SLAVE0_CONFIG (17h)

First external sensor (Sensor1) configuration and sensor hub settings register (r/w).

Table 394. SLAVE0_CONFIG register

SHUB_ ODR_1	SHUB_ ODR_0	0(1)	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 395. SLAVE0_CONFIG register description

SHUB_ODR_[1:0]	Rate at which the master communicates. Default value: 00 (00: 104 Hz (or at the maximum ODR between the accelerometer and gyro if it is less than 104 Hz); 01: 52 Hz (or at the maximum ODR between the accelerometer and gyro if it is less than 52 Hz); 10: 26 Hz (or at the maximum ODR between the accelerometer and gyro if it is less than 26 Hz); 11: 12.5 Hz (or at the maximum ODR between the accelerometer and gyro if it is less than 12.5 Hz)
BATCH_EXT_SENS_0_EN	Enable FIFO batching data of first slave. Default value: 0
Slave0_numop[2:0]	Number of read operations on Sensor 1. Default value: 000

15.23 SLV1_ADD (18h)

I²C slave address of the second external sensor (Sensor 2) register (r/w).

Table 396. SLV1_ADD register

Slave1_ add6	Slave1_ add5	Slave1_ add4	Slave1_ add3	Slave1_ add2	Slave1_ add1	Slave1_ add0	r_1

Table 397. SLV1_ADD register description

Slave1_add[6:0]	I²C slave address of Sensor 2 that can be read by the sensor hub. Default value: 0000000
r_1	Read operation on Sensor 2 enable. Default value: 0 (0: read operation disabled; 1: read operation enabled)

15.24 SLV1_SUBADD (19h)

Address of register on the second external sensor (Sensor 2) register (r/w).

Table 398. SLV1_SUBADD register

Slave1_ reg7	Slave1_ reg6	Slave1_ reg5	Slave1_ reg4	Slave1_ reg3	Slave1_ reg2	Slave1_ reg1	Slave1_ reg0

Table 399. SLV1_SUBADD register description

Slave1_reg[7:0]	Address of register on Sensor 2 that has to be read/written according to the r_1 bit value in *SLV1_ADD (18h)*.

15.25 SLAVE1_CONFIG (1Ah)

Second external sensor (Sensor 2) configuration register (r/w).

Table 400. SLAVE1_CONFIG register

0(1)	0(1)	0(1)	0(1)	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.

Table 401. SLAVE1_CONFIG register description

BATCH_EXT_SENS_1_EN	Enable FIFO batching data of second slave. Default value: 0
Slave1_numop[2:0]	Number of read operations on Sensor 2. Default value: 000

15.26 SLV2_ADD (1Bh)

I^2C slave address of the third external sensor (Sensor 3) register (r/w).

Table 402. SLV2_ADD register

Slave2_ add6	Slave2_ add5	Slave2_ add4	Slave2_ add3	Slave2_ add2	Slave2_ add1	Slave2_ add0	r_2

Table 403. SLV2_ADD register description

Slave2_add[6:0]	I^2C slave address of Sensor 3 that can be read by the sensor hub.
r_2	Read operation on Sensor 3 enable. Default value: 0 (0: read operation disabled; 1: read operation enabled)

15.27 SLV2_SUBADD (1Ch)

Address of register on the third external sensor (Sensor 3) register (r/w).

Table 404. SLV2_SUBADD register

Slave2_ reg7	Slave2_ reg6	Slave2_ reg5	Slave2_ reg4	Slave2_ reg3	Slave2_ reg2	Slave2_ reg1	Slave2_ reg0

Table 405. SLV2_SUBADD register description

Slave2_reg[7:0]	Address of register on Sensor 3 that has to be read/written according to the r_2 bit value in *SLV2_ADD (1Bh)*.

15.28 SLAVE2_CONFIG (1Dh)

Third external sensor (Sensor 3) configuration register (r/w).

Table 406. SLAVE2_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 407. SLAVE2_CONFIG register description

BATCH_EXT_SENS_2_EN	Enable FIFO batching data of third slave. Default value: 0
Slave2_numop[2:0]	Number of read operations on Sensor 3. Default value: 000

15.29 SLV3_ADD (1Eh)

I^2C slave address of the fourth external sensor (Sensor 4) register (r/w).

Table 408. SLV3_ADD register

Slave3_ add6	Slave3_ add5	Slave3_ add4	Slave3_ add3	Slave3_ add2	Slave3_ add1	Slave3_ add0	r_3

Table 409. SLV3_ADD register description

Slave3_add[6:0]	I^2C slave address of Sensor 4 that can be read by the sensor hub.
r_3	Read operation on Sensor 4 enable. Default value: 0 (0: read operation disabled; 1: read operation enabled)

15.30 SLV3_SUBADD (1Fh)

Address of register on the fourth external sensor (Sensor 4) register (r/w).

Table 410. SLV3_SUBADD register

Slave3_ reg7	Slave3_ reg6	Slave3_ reg5	Slave3_ reg4	Slave3_ reg3	Slave3_ reg2	Slave3_ reg1	Slave3_ reg0

Table 411. SLV3_SUBADD register description

Slave3_reg[7:0]	Address of register on Sensor 4 that has to be read according to the r_3 bit value in *SLV3_ADD (1Eh)*.

15.31 SLAVE3_CONFIG (20h)

Fourth external sensor (Sensor 4) configuration register (r/w).

Table 412. SLAVE3_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 413. SLAVE3_CONFIG register description

BATCH_EXT_SENS_3_EN	Enable FIFO batching data of fourth slave. Default value: 0
Slave3_numop[2:0]	Number of read operations on Sensor 4. Default value: 000

15.32 DATAWRITE_SLV0 (21h)

Data to be written into the slave device register (r/w).

Table 414. DATAWRITE_SLV0 register

Slave0_ dataw7	Slave0_ dataw6	Slave0_ dataw5	Slave0_ dataw4	Slave0_ dataw3	Slave0_ dataw2	Slave0_ dataw1	Slave0_ dataw0

Table 415. 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

15.33 STATUS_MASTER (22h)

Sensor hub source register (r).

Table 416. STATUS_MASTER register

WR_ ONCE_ DONE	SLAVE3_ NACK	SLAVE2_ NACK	SLAVE1_ NACK	SLAVE0_ NACK	0	0	SENS_HUB_ ENDOP

Table 417. 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)

16 Soldering information

The LGA package is compliant with the ECOPACK, RoHS and "Green" standard.
It is qualified for soldering heat resistance according to JEDEC J-STD-020.

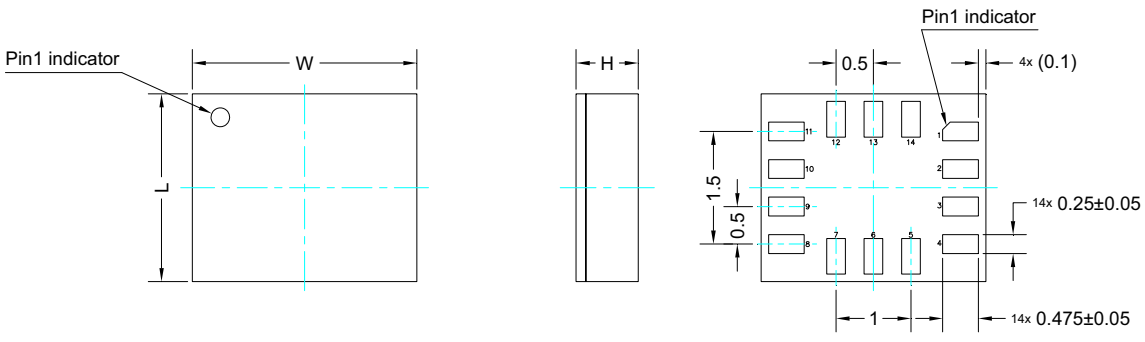
Land pattern and soldering recommendations are available at www.st.com/mems.

17 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.

17.1 LGA-14L package information

Figure 24. LGA-14L 2.5x3x0.86 mm package outline and mechanical data



Dimensions are in millimeter unless otherwise specified
General tolerance is +/-0.1mm unless otherwise specified

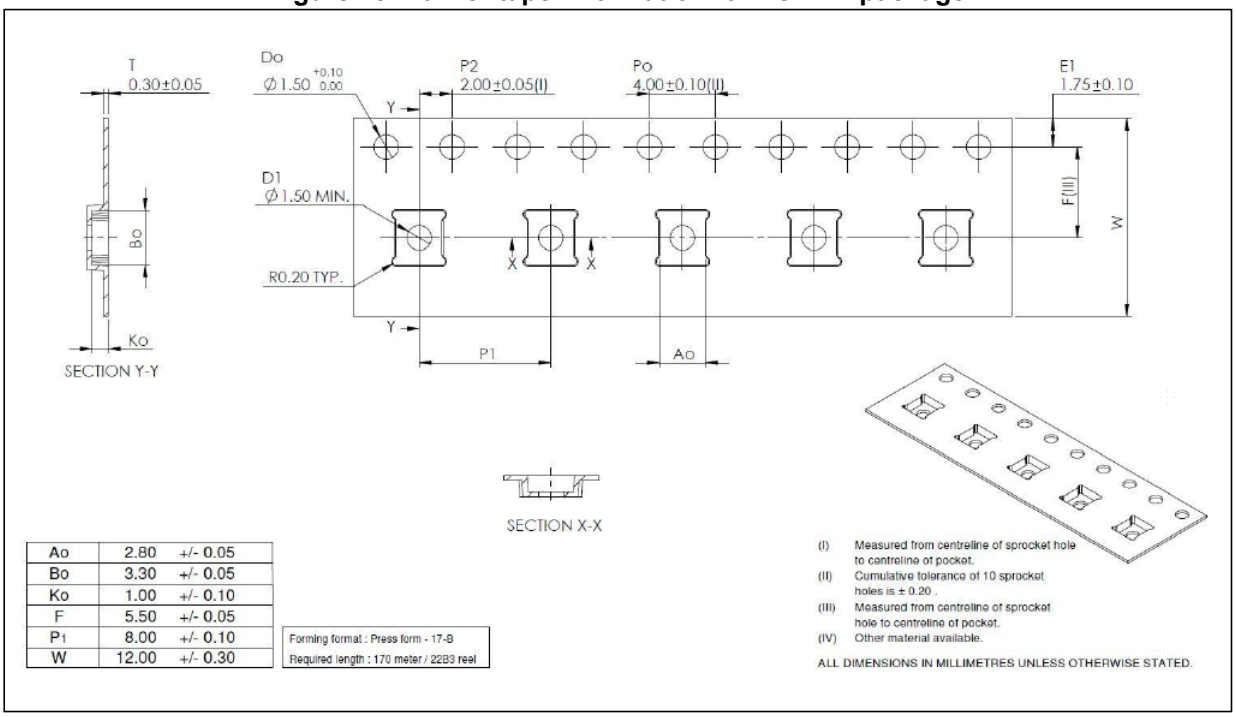
OUTER DIMENSIONS

ITEM	DIMENSION [mm]	TOLERANCE [mm]
Length [L]	2.50	±0.1
Width [W]	3.00	±0.1
Height [H]	0.86	MAX

DM00249496_1

17.2 LGA-14 packing information

Figure 25. 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 26. LGA-14 package orientation in carrier tape

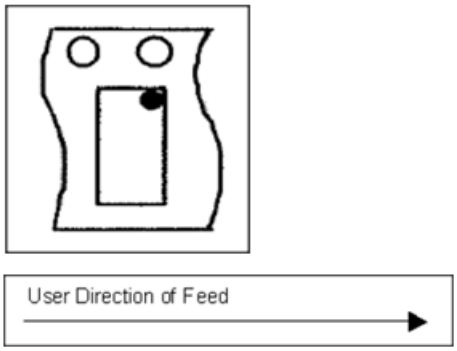


Figure 27. Reel information for carrier tape of LGA-14 package

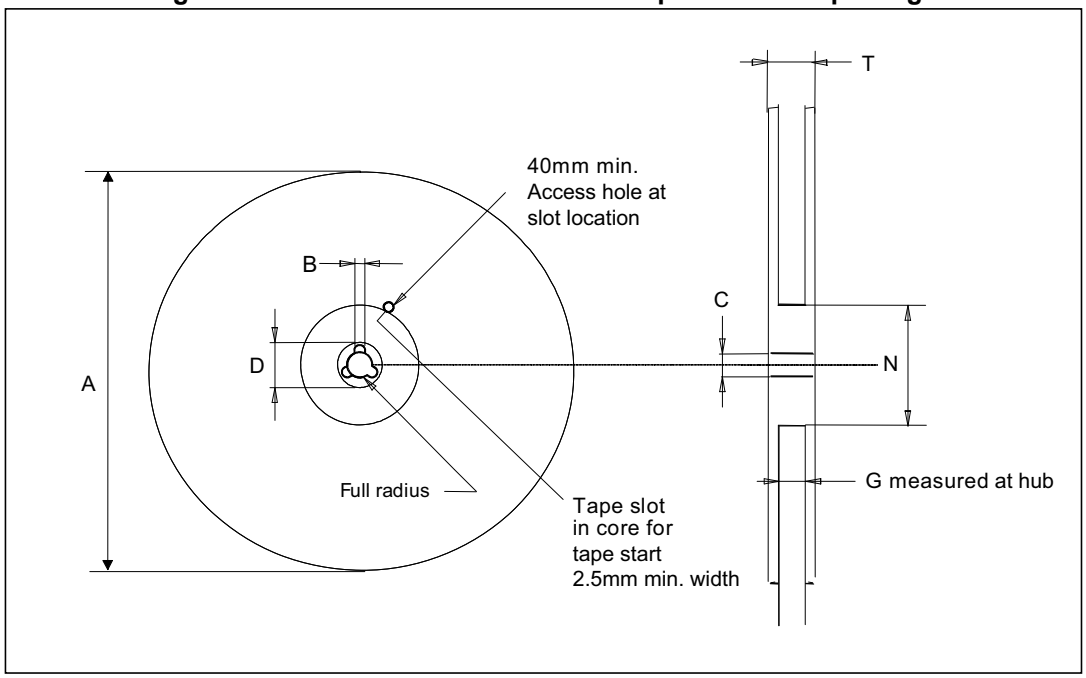


Table 418. Reel dimensions for carrier tape of LGA-14 package

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

18 Revision history

Table 419. Document revision history

Date	Revision	Changes
07-31-2019	3	First public release

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