

High-accuracy 6-axis inertial measurement unit (IMU) for automotive applications



LGA-14L
Typ: 2.5 x 3.0 x 0.83 mm³

Product status link

[ASM330LHB](#)

Product summary

Order code	ASM330LHBTR
Temp. range [°C]	-40 to +105
Package	LGA-14L (2.5 x 3.0 x 0.83 mm ³)
Packing	Tape and reel


Product resources

[AN5914](#) (device application note)
[AN5691](#) (ASIL B library safety manual)
[UM3134](#) (using the ASIL B library in Unico)
[AN5913](#) (finite state machine)
[AN5915](#) (machine learning core)
[TN0018](#) (design and soldering)

Product labels



Features

- AEC-Q100 qualified 
- ASIL B compliant if used in conjunction with a certified software library (ISO 26262:2018)
- Extended temperature range from -40 to +105 °C
- Embedded compensation for high stability over temperature
- Accelerometer user-selectable full scale up to ±16 g
- Extended gyroscope range from ±125 to ±4000 dps
- Dual operating modes: high-performance and low-power mode
- I²C, MIPI I3CSM, and SPI serial interfaces
- Six-channel synchronized output to enhance accuracy of dead-reckoning algorithms
- Programmable finite state machine
- Machine learning core
- Smart programmable interrupts
- Embedded 3 KB FIFO available to underload host processor
- **ECOPACK** and RoHS compliant

Applications

- Satellite precise positioning
- Vehicle-to-everything (V2X)
- ADAS systems
- Active suspension
- Radar, lidar, and camera digital stabilization
- Door/trunk modules
- Motion-activated functions

Description

The **ASM330LHB** is an IMU sensor that offers ASIL B compliance if used in conjunction with a certified software library and features a 3-axis digital accelerometer and a 3-axis digital gyroscope with an extended temperature range up to +105 °C.

A safety manual and a software library, certified according to ISO 26262:2018, are provided to support the development of applications using the ASM330LHB and targeting ASIL B requirements.

ST's family of MEMS sensor modules leverages the robust and mature manufacturing processes already used for the production of micromachined accelerometers and gyroscopes to serve both the automotive and consumer market. The ASM330LHB is AEC-Q100 compliant and industrialized through a dedicated MEMS production flow to meet automotive reliability standards. All the parts are fully tested with respect to temperature to ensure the highest quality level.

The sensing elements are manufactured using ST's proprietary micromachining processes, while the IC interfaces are developed using CMOS technology that allows the design of a dedicated circuit, which is trimmed to better match the characteristics of the sensing element.

The ASM330LHB has a full-scale acceleration range of $\pm 2/\pm 4/\pm 8/\pm 16$ g and a wide angular rate range of $\pm 125/\pm 250/\pm 500/\pm 1000/\pm 2000/\pm 4000$ dps that enable its usage in a broad range of automotive applications.

The device supports dual operating modes: high-performance mode and low-power mode.

All the design aspects of the ASM330LHB have been optimized to reach superior output stability, extremely low noise, and full data synchronization to the benefit of sensor-assisted applications like dead reckoning and sensor fusion.

The ASM330LHB is available in a 14-lead plastic land grid array (LGA) package.

1 Overview

The ASM330LHB is a system-in-package featuring a high-performance 3-axis digital accelerometer and 3-axis digital gyroscope.

This device is suitable for telematics and dead-reckoning applications as well as vehicle-to-vehicle (V2X) and impact detection as a result of its high stability over temperature and time, combined with superior sensing precision.

Supporting dual operating modes, the device has enhanced flexibility versus application requirements, leveraging on multiple voltage and multiple ODR selections. The device also includes digital features like a finite state machine and an ST proprietary machine learning core, allowing defined motion pattern detection or some complex algorithms run in the application processor to be moved to the MEMS sensor with the advantage of consistent reduction in power consumption.

The event-detection interrupts enable efficient and reliable motion-activated functions, implementing hardware recognition of free-fall events, 6D orientation, activity or inactivity, and wake-up events.

Like the entire portfolio of MEMS sensor modules, the ASM330LHB leverages the robust and mature in-house manufacturing processes already used for the production of micromachined accelerometers and gyroscopes. The various sensing elements are manufactured using specialized micromachining processes, while the IC interfaces are developed using CMOS technology that allows the design of a dedicated circuit, which is trimmed to better match the characteristics of the sensing element.

The ASM330LHB is available in a small plastic land grid array (LGA) package of 2.5 x 3.0 x 0.83 mm to address ultra-compact solutions.

This device, used in redundancy (as two modules) and in combination with a dedicated software library, has been evaluated as compatible to be adopted in ASIL B automotive applications. This solution is described in detail in application note AN5691.

2 Embedded low-power features

The ASM330LHB has been designed to feature the following on-chip functions:

- 3 KB data buffering
 - 100% efficiency with flexible configurations and partitioning
 - Possibility to store timestamp
- Event-detection interrupts (fully configurable)
 - Free-fall
 - Wake-up
 - 6D orientation
 - Activity/inactivity recognition
 - Stationary/motion detection
- Specific IP blocks with negligible power consumption and high performance
 - Finite state machine (FSM) for the accelerometer and gyroscope
 - Machine learning core (MLC) for the accelerometer and gyroscope

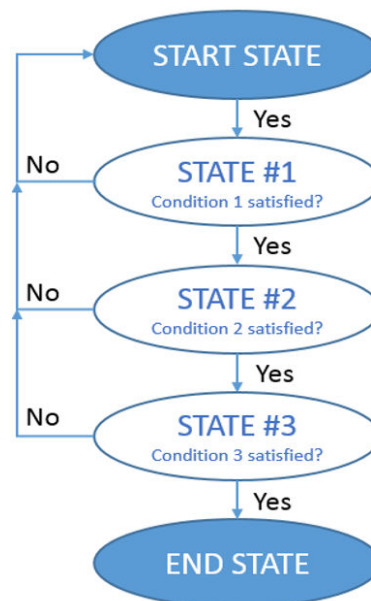
2.1 Finite state machine

The ASM330LHB 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 such as vehicle status (stationary or moving), anti-theft alarm and shock detection.

Definition of finite state machine

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

Figure 1. Generic state machine



Finite state machine in the ASM330LHB

The ASM330LHB works as a combo accelerometer-gyroscope sensor, generating acceleration and angular rate output data. These data can be used as input of up to 16 programs in the embedded finite state machine (Figure 2. State machine in the ASM330LHB).

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 ASM330LHB



2.2 Machine learning core

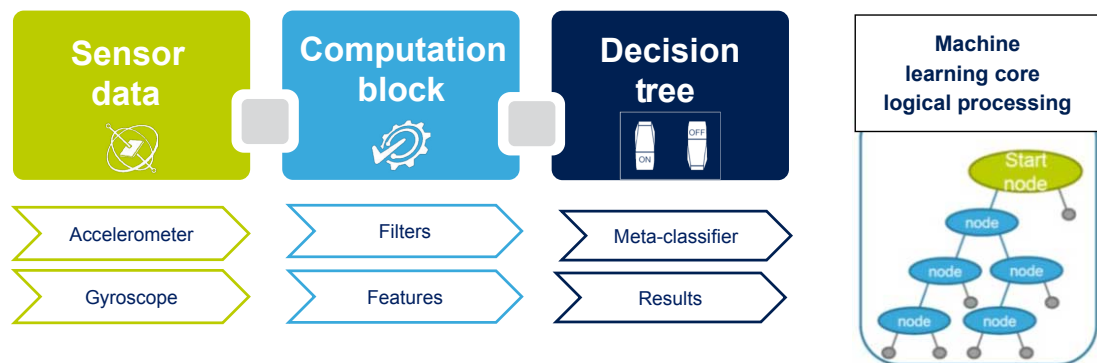
The ASM330LHB embeds a dedicated core for machine learning processing that provides system flexibility, allowing some algorithms run in the application processor to be moved to the MEMS sensor with the advantage of consistent reduction in power consumption.

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

The ASM330LHB machine learning core works on data patterns coming from the accelerometer and gyroscope sensors. 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 ASM330LHB



The ASM330LHB 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 ASM330LHB machine learning core can be configured to generate an interrupt when a change in the result occurs.

3 Pin description

Figure 4. Pin connections

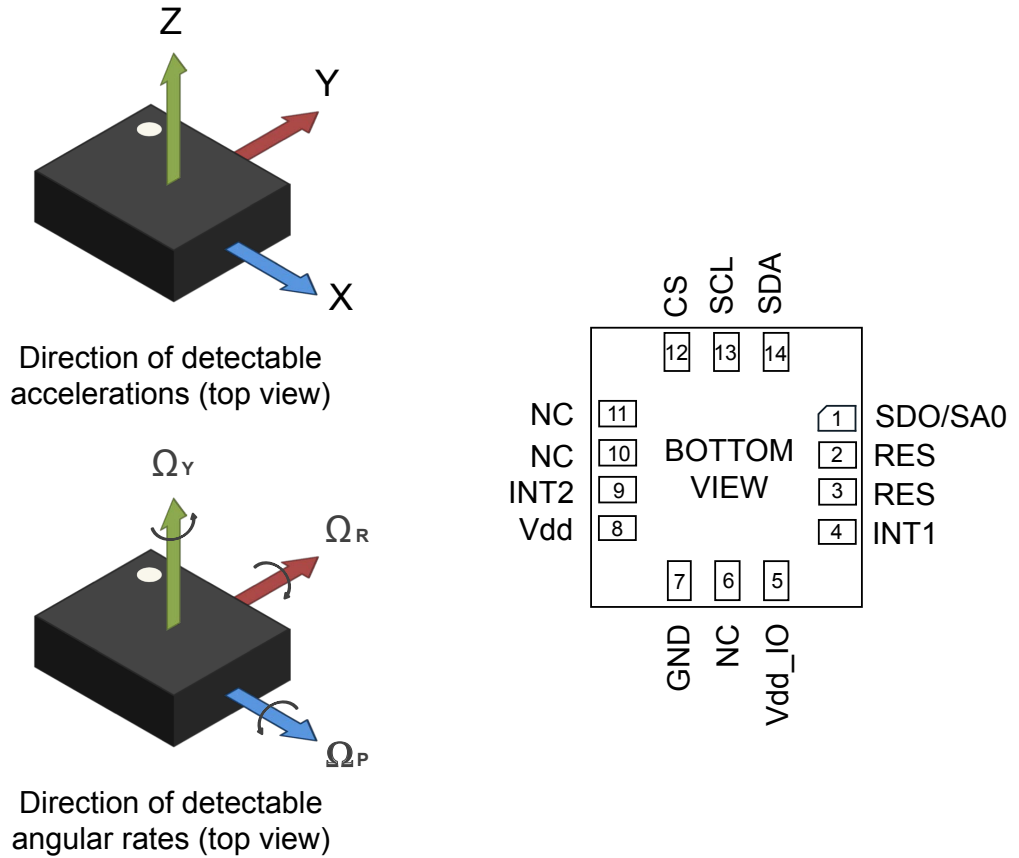


Table 1. Pin description

Pin#	Name	Function
1	SDO/SA0	SPI 4-wire interface serial data output (SDO) I ² C least significant bit of the device address (SA0) MIPI I3C SM least significant bit of the static address (SA0)
2	RES	Connect to Vdd_IO or GND
3	RES	Connect to Vdd_IO or GND
4	INT1	Programmable interrupt in I ² C and SPI
5	Vdd_IO ⁽¹⁾	Power supply for I/O pins
6	NC	Connect to Vdd_IO or GND or leave unconnected
7	GND	0 V supply
8	Vdd ⁽¹⁾	Power supply
9	INT2	Programmable interrupt 2 (INT2) / data enable (DEN)
10	NC	Leave unconnected ⁽²⁾
11	NC	Leave unconnected ⁽²⁾
12	CS	I ² C/MIPI I3C SM /SPI mode selection (1: SPI idle mode / I ² C/MIPI I3C SM communication enabled; 0: SPI communication mode / I ² C/MIPI I3C SM disabled)
13	SCL	I ² C/MIPI I3C SM serial clock (SCL) SPI serial port clock (SPC)
14	SDA	I ² C/MIPI I3C SM serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)

1. Vdd_IO: Recommended 100 nF filter capacitor. Vdd: Recommended 100 nF plus 10 μ F capacitors.

2. Leave pin electrically unconnected and soldered to PCB.

4 Module specifications

4.1 Mechanical characteristics

@Vdd = 3.0 V, T = -40 °C to +105 °C, up to gyroscope FS = ±2000 dps unless otherwise noted.

The product is factory calibrated at 3.0 V. The operational power supply range is from 1.71 V to 3.6 V.

Table 2. Mechanical characteristics

Symbol	Parameter	Test conditions	Min.	Typ. ⁽¹⁾	Max.	Unit
LA_FS	Linear acceleration measurement range			±2		g
				±4		
				±8		
				±16		
G_FS	Angular rate measurement range			±125		dps
				±250		
				±500		
				±1000		
				±2000		
LA_So	Linear acceleration sensitivity	@LA_FS = ±2 g		0.061		mg/LSB
		@LA_FS = ±4 g		0.122		
		@LA_FS = ±8 g		0.244		
		@LA_FS = ±16 g		0.488		
G_So	Angular rate sensitivity	@G_FS = ±125 dps		4.37		mdps/LSB
		@G_FS = ±250 dps		8.75		
		@G_FS = ±500 dps		17.5		
		@G_FS = ±1000 dps		35.0		
		@G_FS = ±2000 dps		70.0		
		@G_FS = ±4000 dps		140.0		
LA_So%	Sensitivity tolerance ⁽²⁾	@25 °C		±2		%
	Sensitivity tolerance - long term ⁽³⁾		-6		+6	%
G_So%	Sensitivity tolerance ⁽²⁾	@25 °C		±2		%
	Sensitivity tolerance - long term ⁽³⁾		-8		+8	%
LA_SoDr	Linear acceleration sensitivity change vs. temperature			±100		ppm/°C
G_SoDr	Angular rate sensitivity change vs. temperature			±70		ppm/°C
LA_TyOff	Linear acceleration zero-g level offset accuracy ⁽²⁾	@25 °C		±20		mg
LA_Off	Linear acceleration offset accuracy - long term ⁽³⁾		-150		+150	mg
G_TyOff	Angular rate zero-rate level accuracy ⁽²⁾	@25 °C		±2		dps
G_Off	Angular rate offset accuracy - long term ⁽³⁾		-7		+7	dps
LA_TCOff	Linear acceleration zero-g level change vs. temperature			±0.10		mg/°C
G_TCOff	Angular rate typical zero-rate level change vs. temperature			±0.005		dps/°C
LA_Cx	Linear acceleration cross-axis sensitivity	@25 °C		±1		%

Symbol	Parameter	Test conditions	Min.	Typ. ⁽¹⁾	Max.	Unit
G_Cx	Angular rate cross-axis sensitivity	@25 °C		±1		%
An	Acceleration noise density ⁽⁴⁾⁽⁶⁾	@LA_FS = ±2 g		60	200	µg/√Hz
AnRMS	Acceleration RMS noise in low-power mode ⁽⁵⁾			1.8		mg(RMS)
Rn	Rate noise density ⁽⁴⁾⁽⁶⁾			5	12	mdps/√Hz
RnRMS	Gyroscope RMS noise in low-power mode ⁽⁵⁾			90		mdps
XL_NL	Accelerometer nonlinearity ⁽⁷⁾	Best-fit straight line		0.5		%FS
G_NL	Gyroscope nonlinearity ⁽⁷⁾	Best-fit straight line		0.01		% FS
VRW	Velocity random walk ⁽⁷⁾	@25 °C		0.03		m/sec/√h
XL_BI	Accelerometer bias instability ⁽⁷⁾	@25 °C		40		µg
ARW	Angular random walk ⁽⁷⁾	@25 °C		0.21		°/√h
G_BI	Gyroscope bias instability ⁽⁷⁾	@25 °C		3		°/h
LA_ODR	Linear acceleration output data rate			1.6 ⁽⁸⁾ 12.5 26 52 104 208 416 833 1667		Hz
G_ODR	Angular rate output data rate			12.5 26 52 104 208 416 833 1667		Hz
Vst	Linear acceleration self-test output change - long term ⁽³⁾⁽⁹⁾⁽¹⁰⁾⁽¹¹⁾		40		1700	mg
	Angular rate self-test output change - long term ⁽³⁾⁽¹²⁾⁽¹³⁾	FS = ±250 dps	20		80	dps
		FS = ±2000 dps	150		700	dps
Top	Operating temperature range		-40		+105	°C

1. Typical specifications are not guaranteed.
2. Values after factory calibration test and trimming at T = 25 °C.
3. Long term includes the following conditions: post solder, drift in temperature in the range [-40°C to +105 °C] and over life.
4. Max. values from design and characterization at ambient temperature (T = 25 °C).
5. RMS noise is the same for all ODRs.
6. Noise density is the same for all ODRs.
7. Based on characterization data on a limited number of samples. Not measured during final test for production.
8. This ODR is available when the accelerometer is in low-power mode.
9. Accelerometer self-test limits are full-scale independent.
10. The sign of the linear acceleration self-test output change is defined by the STx_XL bits in a dedicated register for all axes.
11. The linear acceleration self-test output change is defined with the device in stationary condition as the absolute value of: OUTPUT[LSb] (self-test enabled) - OUTPUT[LSb] (self-test disabled). 1LSb = 0.061 mg at ±2 g full scale.

12. 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.

13. The sign of the angular rate self-test output change is defined by the STx_G bits in a dedicated register for all axes.

4.2 Electrical characteristics

@Vdd = 3.0 V, T = -40 °C to +105 °C, up to gyroscope FS = ± 2000 dps unless otherwise noted.

Table 3. Electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ. ⁽¹⁾	Max.	Unit
Vdd	Supply voltage		1.71		3.6	V
Vdd_IO	Power supply for I/O		1.62		3.6	V
GA_Idd	Gyroscope and accelerometer current consumption	ODR = 1.6 kHz		1.3	1.6	mA
A_IddHP	Accelerometer current consumption in high-performance mode	ODR = 1.6 kHz		360	530	μ A
LA_IddLM	Accelerometer current consumption in low-power mode	ODR = 52 Hz, @25 °C		50	150	μ A
		ODR = 12.5 Hz, @25 °C ⁽³⁾		14		μ A
		ODR = 1.6 Hz, @25 °C ⁽³⁾		7		μ A
		Vdd = 1.71 V, ODR = 52 Hz, @25 °C		40	150	μ A
		Vdd = 1.71 V, ODR = 12.5 Hz, @25 °C ⁽³⁾		11		μ A
		Vdd = 1.71 V, ODR = 1.6 Hz, @25 °C ⁽³⁾		5.5		μ A
LC_IddLM	Current consumption in low-power mode, combo mode	ODR = 52 Hz		530	800	μ A
		ODR = 12.5 Hz, @25 °C ⁽³⁾		475		μ A
		Vdd = 1.71 V, ODR = 52 Hz		520	800	μ A
		Vdd = 1.71 V, ODR = 12.5 Hz, @25 °C ⁽³⁾		470		μ A
IddPD	Gyroscope and accelerometer current consumption during power-down	@25 °C		5	13	μ A
Ton	Turn-on time ⁽²⁾			35		ms
V _{IH} ⁽³⁾	Digital high-level input voltage		0.7 * Vdd_IO			V
V _{IL} ⁽³⁾	Digital low-level input voltage				0.3 * Vdd_IO	V
V _{OH} ⁽³⁾	High-level output voltage	I _{OH} = 4 mA ⁽⁴⁾	Vdd_IO - 0.2			V
V _{OL} ⁽³⁾	Low-level output voltage	I _{OL} = 4 mA ⁽⁴⁾			0.2	V
Top	Operating temperature range		-40		+105	°C

1. Typical specifications are not guaranteed.

2. Time to obtain stable sensitivity (within $\pm 5\%$ of final value) switching from power-down to normal operation

3. Evaluated by characterization - not tested in production

4. 4 mA is the minimum driving capability, that is, 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 = 3.0 V, T = 25 °C unless otherwise noted. The product is factory calibrated at 3.0 V.

Table 4. Temperature sensor characteristics

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

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

4.4 Communication interface characteristics

4.4.1 SPI - serial peripheral interface

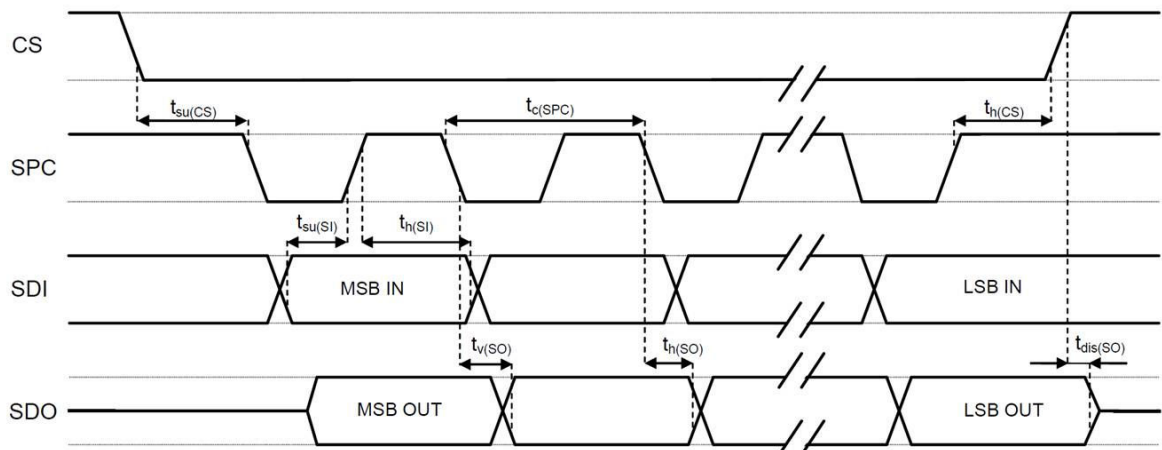
Subject to general operating conditions for Vdd and Top.

Table 5. 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 evaluated at 10 MHz clock frequency for SPI with both 4 and 3 wires, based on characterization results, not tested in production

Figure 5. SPI slave timing diagram (in mode 3)



Note: Measurement points are done at $0.3 \cdot V_{dd_IO}$ and $0.7 \cdot V_{dd_IO}$ for both input and output ports.

4.4.2 I²C - inter-IC control interface

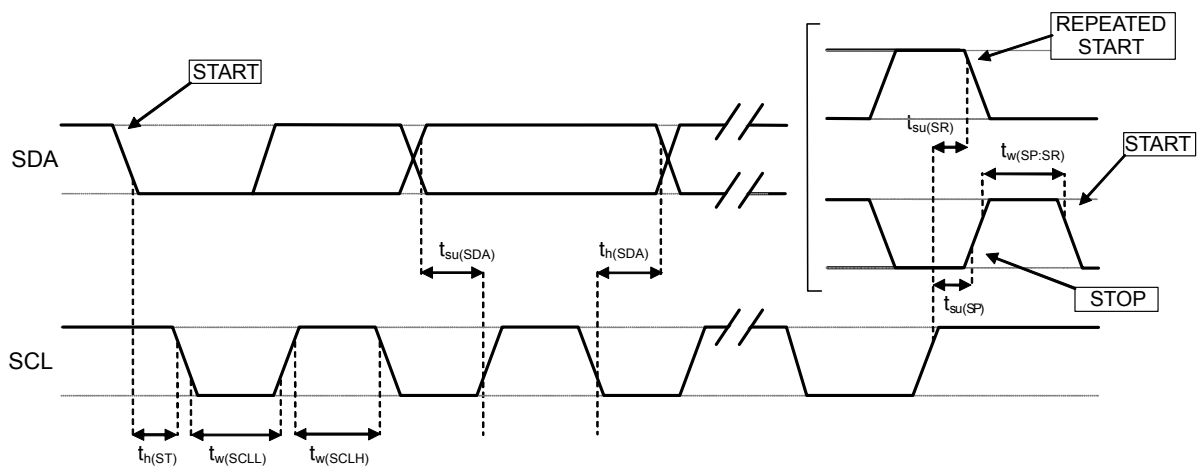
Subject to general operating conditions for V_{dd} and Top.

Table 6. I²C slave timing values

Symbol	Parameter	I ² C standard mode ⁽¹⁾		I ² C 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		
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 6. I²C slave timing diagram



Note: Measurement points are done at 0.3·V_{dd_IO} and 0.7·V_{dd_IO} for both ports.

Table 7. I²C high-speed mode specifications at 1 MHz

	Symbol	Parameter	Min.	Max.	Unit
Fast mode plus ⁽¹⁾	f _{SCL}	SCL clock frequency	0	1	MHz
	t _{HD;STA}	Hold time (repeated) START condition	260	-	ns
	t _{LOW}	Low period of the SCL clock	500	-	
	t _{HIGH}	High period of the SCL clock	260	-	
	t _{SU;STA}	Setup time for a repeated START condition	260	-	
	t _{HD;DAT}	Data hold time	0	-	
	t _{SU;DAT}	Data setup time	50	-	
	t _{rDA}	Rise time of SDA signal	-	120	
	t _{fDA}	Fall time of SDA signal	-	120	
	t _{rCL}	Rise time of SCL signal	20*V _{dd} /5.5	120	
	t _{fCL}	Fall time of SCL signal	20*V _{dd} /5.5	120	
	t _{SU;STO}	Setup time for STOP condition	260	-	
	C _b	Capacitive load for each bus line	-	550	pF
	t _{VD;DAT}	Data valid time	-	450	ns
	t _{VD;ACK}	Data valid acknowledge time	-	450	
	V _{nL}	Noise margin at low level	0.1V _{dd}	-	V
	V _{nH}	Noise margin at high level	0.2V _{dd}	-	
t _{SP}	Pulse width of spikes that must be suppressed by the input filter	0	50	ns	

1. Data based on characterization, not tested in production

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 <i>g</i> for 0.3 ms	3000	<i>g</i>
ESD	Electrostatic discharge protection (HBM)	2	kV
V _{in}	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 2](#)).

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 2](#)).

4.6.2 Zero-g and zero-rate level

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

Offset is to some extent a result of stress to the MEMS sensor and therefore the offset can slightly change after mounting the sensor onto a printed circuit board or exposing it to extensive mechanical stress. Offset changes little over temperature, see "Linear acceleration zero-g level change vs. temperature" in [Table 2](#). 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 2](#)).

5 Digital interfaces

The ASM330LHB offers two communication protocols I²C / MIPI I3CSM slave interface or SPI (3- and 4-wire) serial interface.

Figure 7. Reference design - block diagram, I²C communication protocol

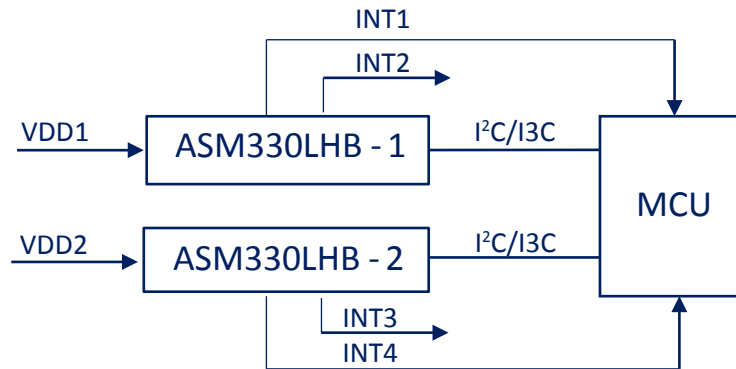
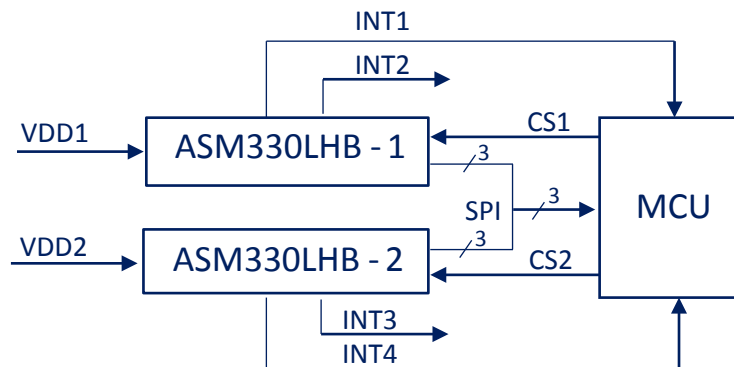


Figure 8. Reference design - block diagram, SPI4 communication protocol



5.1 I²C/SPI interface

The registers embedded inside the ASM330LHB may be accessed through both the I²C and SPI serial interfaces. The latter may be software-configured to operate either in 3-wire or 4-wire interface mode. The device is compatible with SPI modes 0 and 3.

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

Table 9. Serial interface pin description

Pin name	Pin description
CS	Enable SPI I ² C/SPI mode selection (1: SPI idle mode / I ² C communication enabled; 0: SPI communication mode / I ² C disabled)
SCL/SPC	I ² C serial clock (SCL) SPI serial port clock (SPC)
SDA/SDI/SDO	I ² C serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)
SDO/SA0	SPI serial data output (SDO) I ² C less significant bit of the device address

5.1.1 I²C serial interface

The ASM330LHB I²C is a bus slave. The I²C is employed to write the data to the registers, whose content can also be read back.

The relevant I²C terminology is provided in the table below.

Table 10. I²C terminology

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

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

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

In order to disable the I²C block, (I2C_disable) = 1 must be written in CTRL4_C (13h).

5.1.1.1 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 ASM330LHB 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 ASM330LHB behaves like a slave device and the following protocol must be adhered to. After the start condition (ST) a slave address is sent, once a slave acknowledge (SAK) has been returned, an 8-bit subaddress (SUB) is transmitted. The increment of the address is configured by 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 subaddress bytes; if the bit is 0 (write) the master transmits 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	

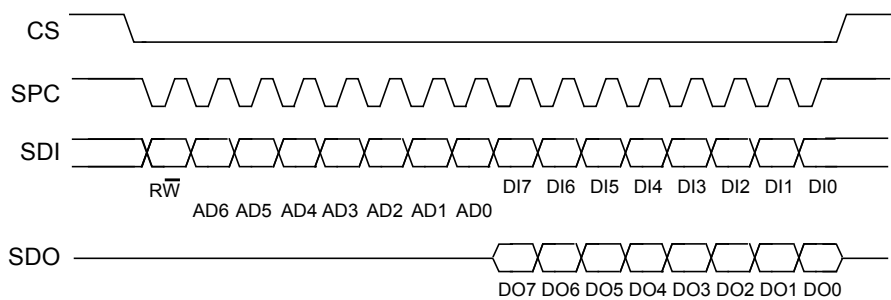
Data are transmitted in byte format (DATA). Each data transfer contains 8 bits. The number of bytes transferred per transfer is unlimited. Data is transferred with the most significant bit (MSb) first. If a slave receiver doesn't acknowledge the slave address (that is, it is not able to receive because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

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

5.1.2 SPI bus interface

The ASM330LHB SPI is a bus slave. The SPI allows writing to and reading from the registers of the device. The serial interface communicates to the application using 4 wires: **CS**, **SPC**, **SDI** and **SDO**.

Figure 9. Read and write protocol (in mode 3)



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

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

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

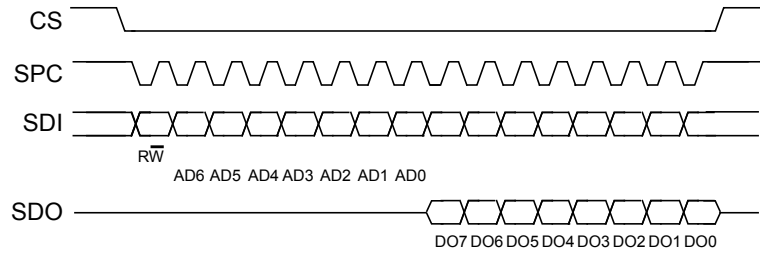
bit 1-7: address AD(6:0). This is the address field of the indexed register.

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

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

In multiple read/write commands further blocks of 8 clock periods are added. When the **CTRL3_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.

5.1.2.1 SPI read
Figure 10. SPI read protocol (in mode 3)


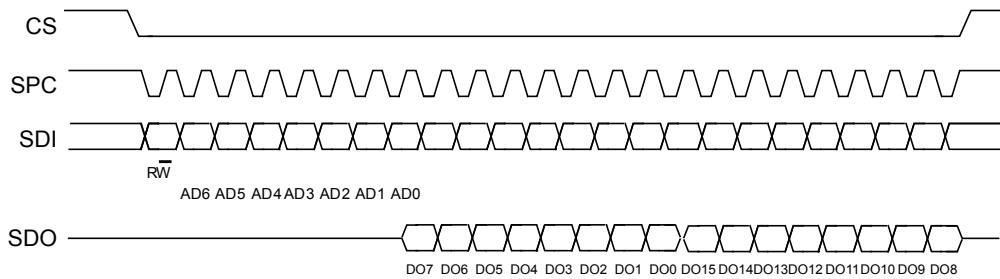
The SPI read command is performed with 16 clock pulses. A multiple byte read command is performed by adding blocks of 8 clock pulses to the previous one.

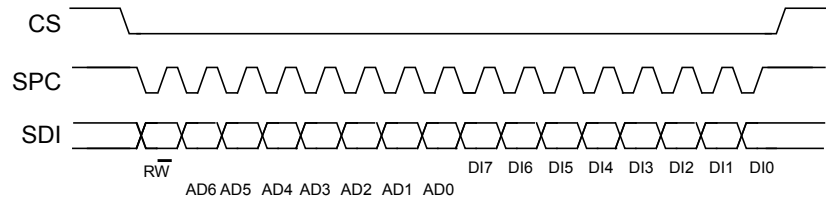
bit 0: READ bit. The value is 1.

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

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

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

Figure 11. Multiple byte SPI read protocol (2-byte example) (in mode 3)


5.1.2.2 SPI write
Figure 12. SPI write protocol (in mode 3)


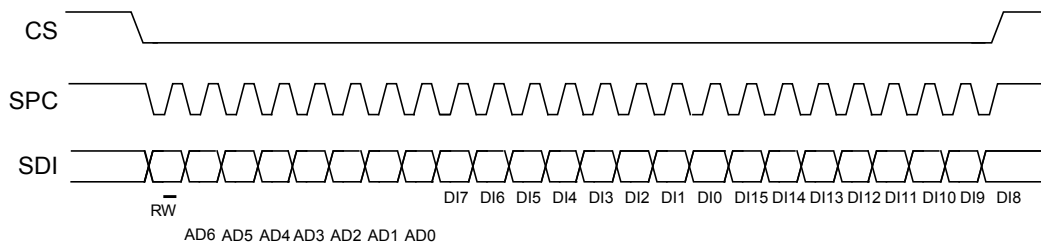
The SPI write command is performed with 16 clock pulses. A multiple byte write command is performed by adding blocks of 8 clock pulses to the previous one.

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).

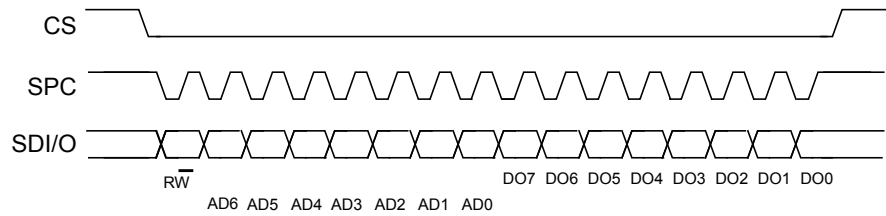
bit 16-... : data DI(...-8). Further data in multiple byte writes.

Figure 13. Multiple byte SPI write protocol (2-byte example) (in mode 3)


5.1.2.3 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 14. 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 MIPI I3CSM interface

5.2.1 MIPI I3CSM slave interface

The ASM330LHB interface includes a MIPI I3CSM SDR only slave interface with MIPI I3CSM SDR embedded features:

- CCC command
- Direct CCC communication (SET and GET)
- Broadcast CCC communication
- Private communications
- Private read and write for single byte
- Multiple read and write
- Error detection and recovery methods

Refer to [Section 5.3 I²C/I3C coexistence in ASM330LHB](#) for details concerning the choice of the interface when powering up the device.

5.2.2 MIPI I3CSM CCC supported commands

The list of MIPI I3CSM CCC commands supported by the device is detailed in the following table.

Table 16. MIPI I3CSM CCC commands

Command	Command code	Default	Description
ENTDAA	0x07		DAA procedure
SETDASA	0x87		Assign dynamic address using static address 0x6B/0x6A depending on SDO pin
ENEC	0x80 / 0x00		Slave activity control (direct and broadcast)
DISEC	0x81/ 0x01		Slave activity control (direct and broadcast)
ENTAS0	0x82 / 0x02		Enter activity state (direct and broadcast)
ENTAS1	0x83 / 0x03		Enter activity state (direct and broadcast)
ENTAS2	0x84 / 0x04		Enter activity state (direct and broadcast)
ENTAS3	0x85 / 0x05		Enter activity state (direct and broadcast)
RSTDAA	0x86 / 0x06		Reset the assigned dynamic address (direct and broadcast)
SETMWL	0x89 / 0x08		Define maximum write length during private write (direct and broadcast)
SETMRL	0x8A / 0x09		Define maximum read length during private read (direct and broadcast)
SETNEWDA	0x88		Change dynamic address
GETMWL	0x8B	0x00 0x08 (2 byte)	Get maximum write length during private write
GETMRL	0x8C	0x00 0x10 0x09 (3 byte)	Get maximum read length during private read
GETPID	0x8D	0x02 0x08 0x00 0x6B 0x10 0x0B	Device ID register

Command	Command code	Default	Description
GETBCR	0x8E	0x07 (1 byte)	Bus characteristics register
GETDCR	0x8F	0x00	MIPI I3CSM SM device characteristics register
GETSTATUS	0x90	0x00 0x00 (2 byte)	Status register
GETMXDS	0x94	0x00 0x38 (2 byte)	Return max data speed ⁽¹⁾

1. Bits[5:3] are set to "111" which indicates that T_{sco} is greater than 12 nsec. To calculate the effective bus frequency, T_{sco} should be used together with line capacitance, number of slaves and stubs (if present).

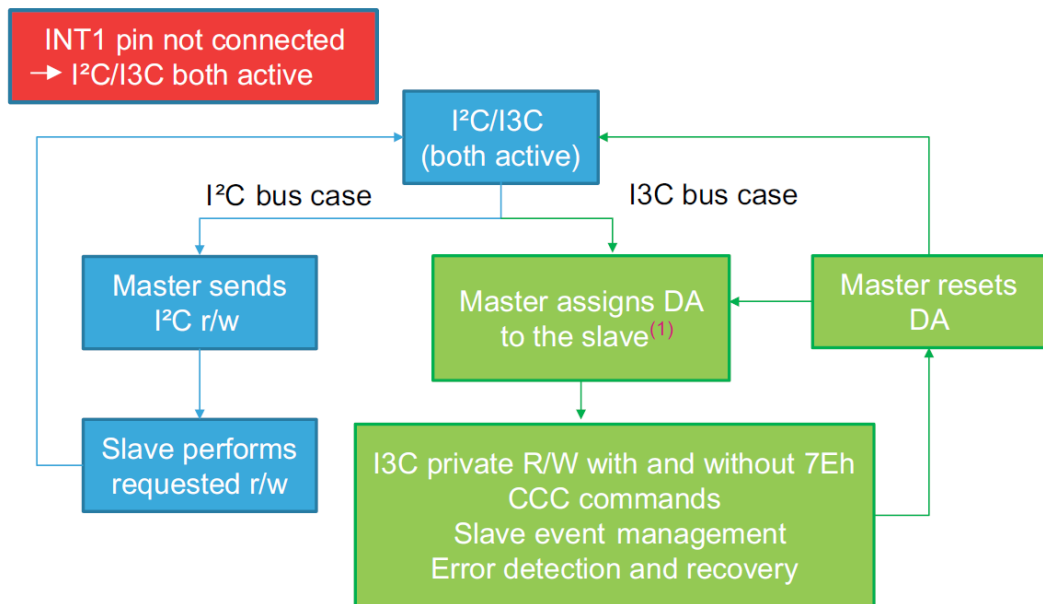
5.3 I²C/I³C coexistence in ASM330LHB

In the ASM330LHB, the SDA and SCL lines are common to both I²C and I³C. The I²C bus requires anti-spike filters on the SDA and SCL pins that are not compatible with I³C timing.

The device can be connected to both I²C and I³C or only to the I³C bus depending on the connection of the INT1 pin when the device is powered up:

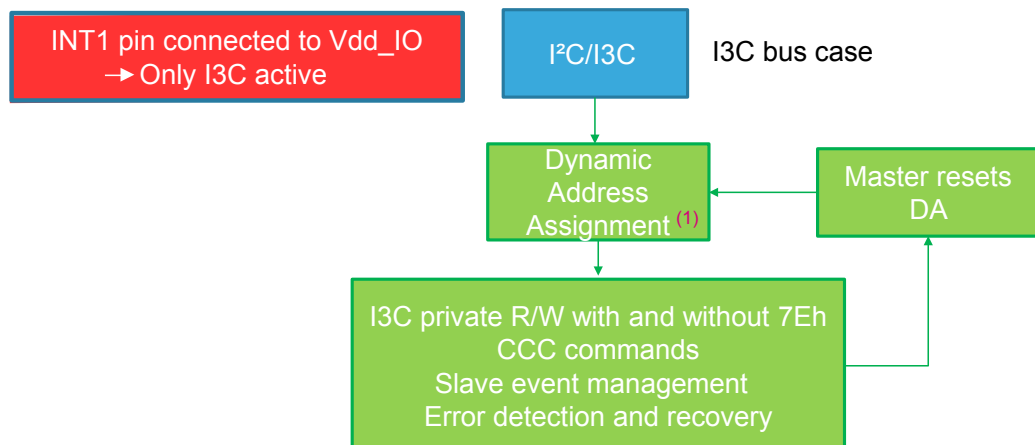
- INT1 pin floating (internal pull-down): I²C/I³C both active, see Figure 15
- INT1 pin connected to Vdd_IO: only I³C active, see Figure 16

Figure 15. I²C and I³C both active (INT1 pin not connected)



1. Address assignment (DAA or ENTDA) must be performed with I²C fast mode plus timing. When the slave is addressed, the I²C slave is disabled and the timing is compatible with I³C specifications.

Figure 16. Only I³C active (INT1 pin connected to Vdd_IO)



1. When the slave is I³C only, the I²C slave is always disabled. The address can be assigned using I³C SDR timing.

6 Functionality

6.1 Operating modes

In the ASM330LHB, 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 ASM330LHB 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.

Note: If the accelerometer is to be activated in high-performance operating mode while the gyroscope is already running (that is, the gyroscope is not in power-down mode), proceed as follows:

1. Disable the accelerometer high-performance operating mode (set the XL_HM_MODE bit to 1 in the [CTRL6_C \(15h\)](#) register).
2. Write the [CTRL1_XL \(10h\)](#) register to 50h.
3. Read the [OUTZ_H_A \(2Dh\)](#) register to clear the XLDA bit in the [STATUS_REG \(1Eh\)](#) register.
4. Wait for 1/ODR_XL time period or wait until the XLDA bit in the [STATUS_REG \(1Eh\)](#) register becomes equal to 1.
5. Enable the accelerometer high-performance operating mode (set the XL_HM_MODE bit to 0 in the [CTRL6_C \(15h\)](#) register).
6. Write the [CTRL1_XL \(10h\)](#) register to the desired value.

6.2 Gyroscope power modes

In the ASM330LHB, the gyroscope can be configured in two different operating modes: low-power 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 1.67 kHz).

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

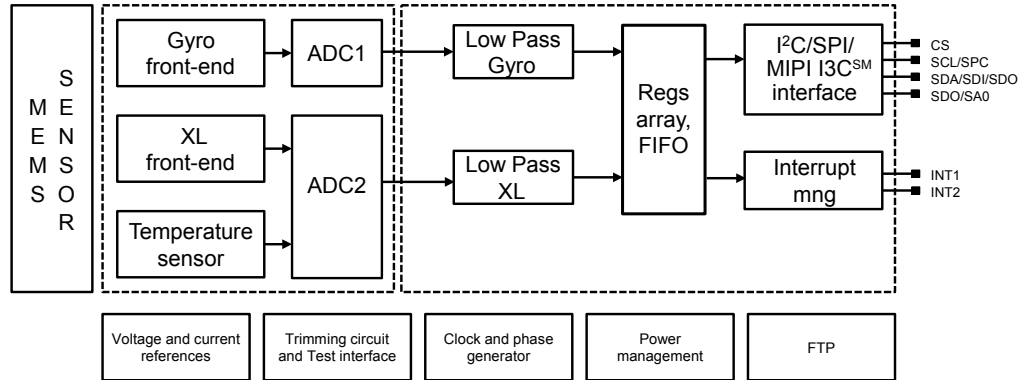
6.3 Accelerometer power modes

In the ASM330LHB, the accelerometer can be configured in two different operating modes: low-power 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 1.67 kHz).

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

6.4 Block diagram of filters

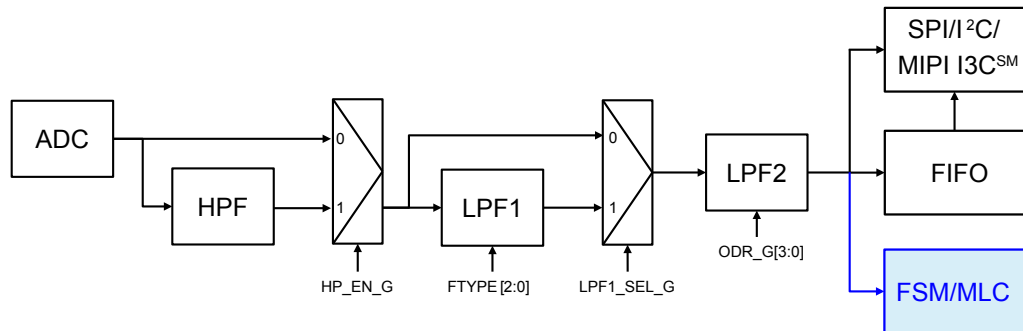
Figure 17. Block diagram of filters



6.4.1 Block diagram of the gyroscope filter

The gyroscope filtering chain appears below.

Figure 18. Gyroscope filtering chain



The gyroscope ODR is selectable from 12.5 Hz up to 1.67 kHz. A low-pass filter (LPF1) is available, for more details about the filter characteristics see [Table 58. 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.

Data can be acquired from the output registers and FIFO.

Table 17. 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

6.4.2 Block diagrams of the accelerometer filters

In the ASM330LHB, the filtering chain for the accelerometer part is composed of the following:

- Digital filter (LPF1)
- Composite filter

Details of the block diagram appear in the following figure.

Figure 19. Accelerometer chain

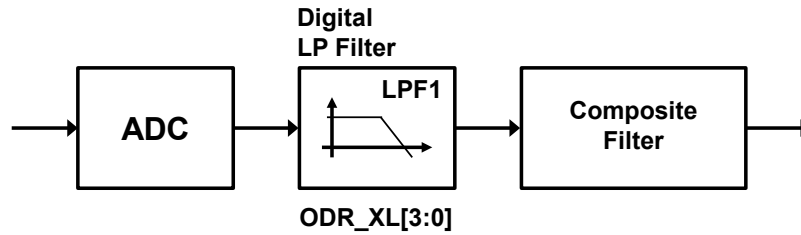
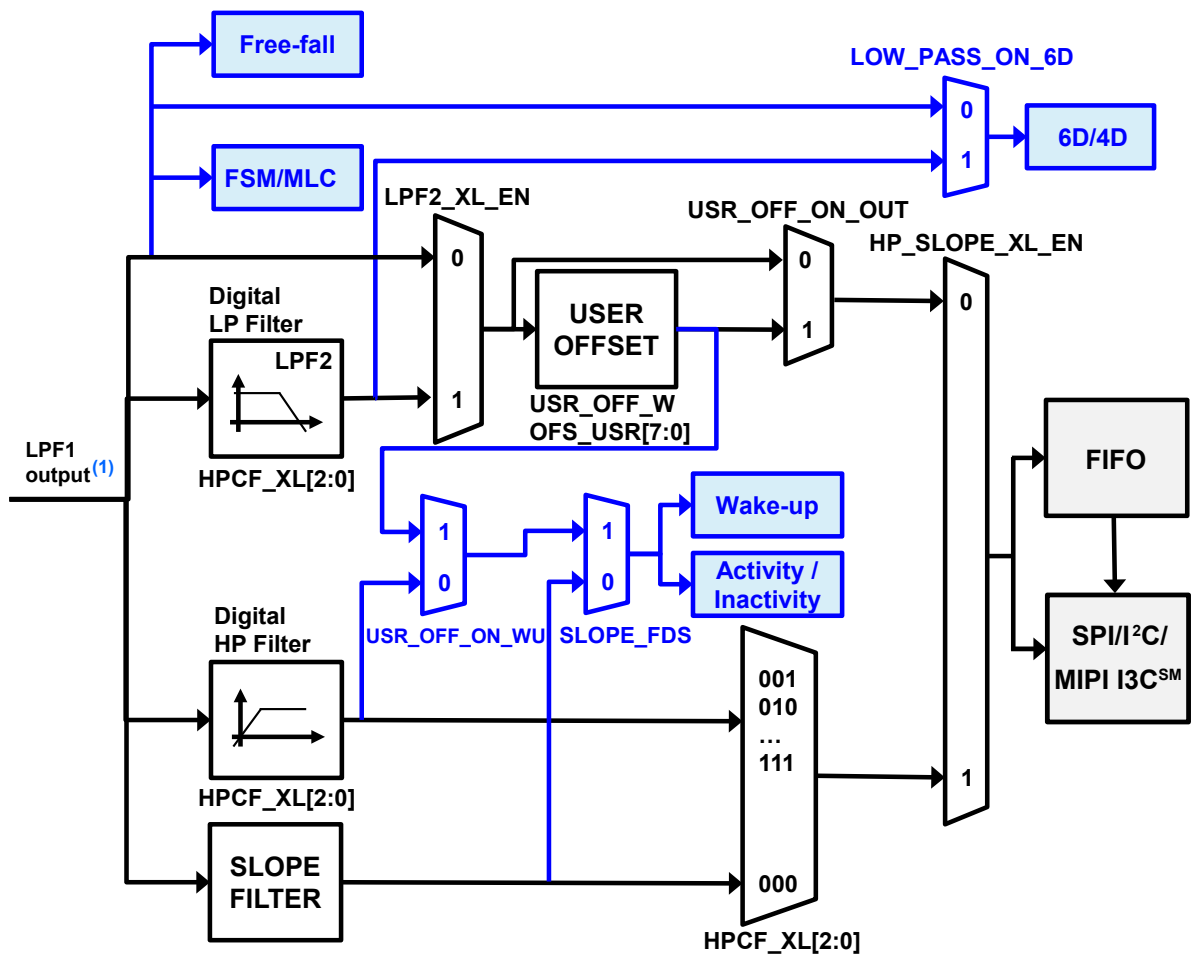


Figure 20. Accelerometer composite filter



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

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 ASM330LHB embeds 3 KB of data in FIFO to store the following data:

- Gyroscope
- Accelerometer
- Timestamp
- Temperature

Writing data in the FIFO is triggered by the accelerometer / gyroscope data-ready signal.

The applications have maximum flexibility in choosing the rate of batching for physical sensors with FIFO-dedicated configurations: accelerometer, gyroscope and temperature sensor batch rates can be selected by the user. It is possible to select decimation for timestamp batching in FIFO with a factor of 1, 8, or 32.

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

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

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 3 KB of data 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 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:

- 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:

- 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:

- 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.

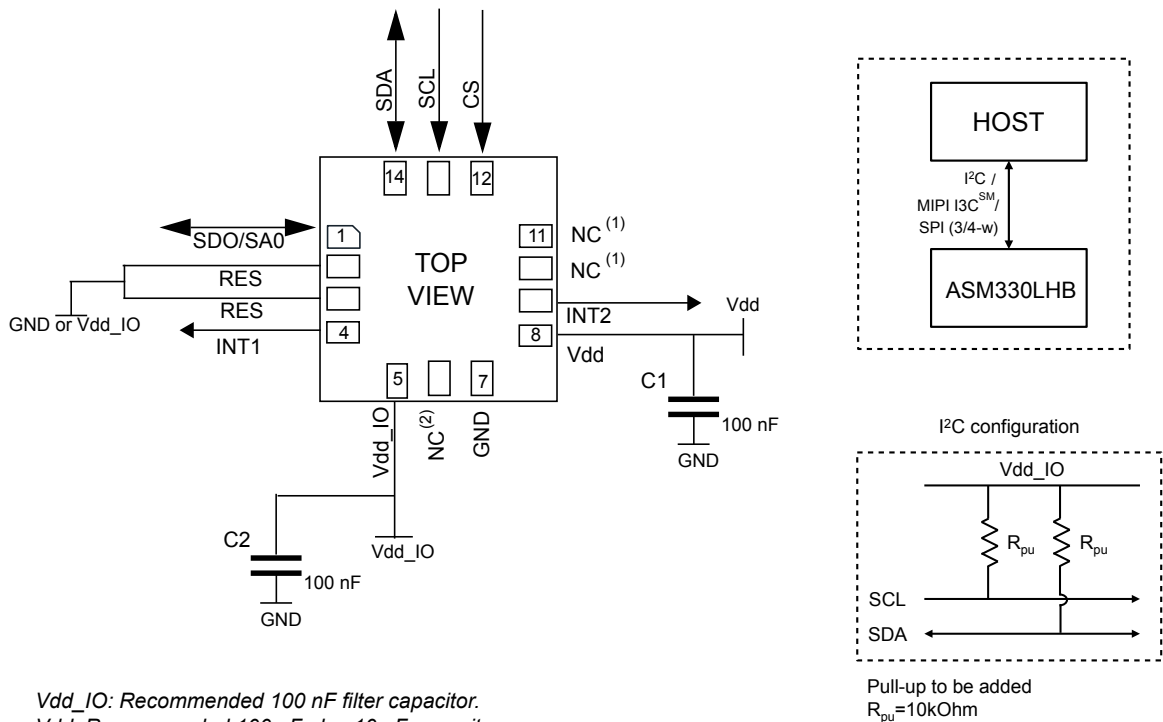
In addition, it is possible to configure a counter of the batch events of accelerometer or gyroscope sensors. The flag **COUNTER_BDR_IA** in **FIFO_STATUS2 (3Bh)** alerts that the counter reaches a selectable threshold (**CNT_BDR_TH_[10:0]** field in **COUNTER_BDR_REG1 (0Bh)** and **COUNTER_BDR_REG2 (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 to 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)**).

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 ASM330LHB electrical connections

Figure 21. ASM330LHB electrical connections



1. Leave pin electrically unconnected and soldered to PCB.
2. Connect to Vdd_IO or GND or leave unconnected and soldered to PCB.

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

The functionality of the device and the measured acceleration/angular rate data is selectable and accessible through the SPI/I²C/MIPI I3CSM primary interface.

The functions, the threshold and the timing of the two interrupt pins for each sensor can be completely programmed by the user through the SPI/I²C/MIPI I3CSM primary interface.

Table 18. Internal pin status

Pin #	Name	Pin function	Pin status
1	SDO	SPI 4-wire interface serial data output (SDO)	Default: input without pull-up Pull-up is enabled if bit SDO_PU_EN = 1 in register PIN_CTRL (02h).
	SA0	I ² C least significant bit of the device address (SA0) MIPI I3C SM least significant bit of the static address (SA0)	
2	MSDA	Connect to Vdd_IO or GND	Default: input without pull-up (see Note to enable pull-up)
3	MSCL	Connect to Vdd_IO or GND	Default: input without pull-up (see Note to enable pull-up)
4	INT1	Programmable interrupt 1.	Default: input with pull-down ⁽¹⁾
		If device is used as MIPI I3C SM pure slave, this pin must be set to 1.	Pull-down is disabled if bit PD_DIS_INT1 = 1 in register I3C_BUS_AVB (62h).
5	Vdd_IO	Power supply for I/O pins	
6	NC	Connect to Vdd_IO or GND or leave unconnected	
7	GND	0 V supply	
8	Vdd	Power supply	
9	INT2	Programmable interrupt 2 (INT2) / data enabled (DEN)	Default: output forced to ground
10	NC	Leave unconnected	
11	NC	Leave unconnected	
12	CS	I ² C and MIPI I3C SM /SPI mode selection	Default: input with pull-up
		(1:SPI idle mode / I ² C and MIPI I3C SM communication enabled; 0: SPI communication mode / I ² C and MIPI I3C SM disabled)	Pull-up is disabled if bit I2C_disable = 1 in register CTRL4_C (13h) and I3C_disable = 1 in register CTRL9_XL (18h).
13	SCL	I ² C/MIPI I3C SM serial clock (SCL) / SPI serial port clock (SPC)	Default: input without pull-up
14	SDA	I ² C/MIPI I3C SM serial data (SDA) / SPI serial data input (SDI) /	Default: input without pull-up
		3-wire interface serial data output (SDO)	

1. 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 Vdd_IO.

Note:

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

1. From the primary I²C/I3C/SPI interface: write 40h in register at address 01h
2. From the primary I²C/I3C/SPI interface: write 08h in register at address 14h (enable the pull-up on pins 2 and 3)
3. From the primary I²C/I3C/SPI interface: write 00h in register at address 01h

8 Register map

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

Table 19. Registers address map

Name	Type	Register address		Default	Comment
		Hex	Binary		
FUNC_CFG_ACCESS	R/W	01	00000001	00000000	
PIN_CTRL	R/W	02	00000010	00111111	
RESERVED	-	03-06			Reserved
FIFO_CTRL1	R/W	07	00000111	00000000	
FIFO_CTRL2	R/W	08	00001000	00000000	
FIFO_CTRL3	R/W	09	00001001	00000000	
FIFO_CTRL4	R/W	0A	00001010	00000000	
COUNTER_BDR_REG1	R/W	0B	00001011	00000000	
COUNTER_BDR_REG2	R/W	0C	00001100	00000000	
INT1_CTRL	R/W	0D	00001101	00000000	
INT2_CTRL	R/W	0E	00001110	00000000	
WHO_AM_I	R	0F	00001111	01101011	
CTRL1_XL	R/W	10	00010000	00000000	
CTRL2_G	R/W	11	00010001	00000000	
CTRL3_C	R/W	12	00010010	00000100	
CTRL4_C	R/W	13	00010011	00000000	
CTRL5_C	R/W	14	00010100	00000000	
CTRL6_C	R/W	15	00010101	00000000	
CTRL7_G	R/W	16	00010110	00000000	
CTRL8_XL	R/W	17	00010111	00000000	
CTRL9_XL	R/W	18	00011000	11100000	
CTRL10_C	R/W	19	00011001	00000000	
ALL_INT_SRC	R	1A	00011010	output	
WAKE_UP_SRC	R	1B	00011011	output	
RESERVED	-	1C			Reserved
D6D_SRC	R	1D	00011101	output	
STATUS_REG	R	1E	00011110	output	
RESERVED	-	1F			Reserved
OUT_TEMP_L	R	20	00100000	output	
OUT_TEMP_H	R	21	00100001	output	
OUTX_L_G	R	22	00100010	output	
OUTX_H_G	R	23	00100011	output	
OUTY_L_G	R	24	00100100	output	
OUTY_H_G	R	25	00100101	output	
OUTZ_L_G	R	26	00100110	output	

Name	Type	Register address		Default	Comment
		Hex	Binary		
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			Reserved
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	
RESERVED	-	39			Reserved
FIFO_STATUS1	R	3A	00111010	output	
FIFO_STATUS2	R	3B	00111011	output	
RESERVED	-	3C-3F			Reserved
TIMESTAMP0_REG	R	40	01000000	output	
TIMESTAMP1_REG	R	41	01000001	output	
TIMESTAMP2_REG	R	42	01000010	output	
TIMESTAMP3_REG	R	43	01000011	output	
RESERVED	-	44-55			Reserved
INT_CFG0	R/W	56	01010110	00000000	
RESERVED	-	57			Reserved
INT_CFG1	R/W	58	01011000	00000000	
THS_6D	R/W	59	01011001	00000000	
RESERVED	-	5A			Reserved
WAKE_UP_THS	R/W	5B	01011011	00000000	
WAKE_UP_DUR	R/W	5C	01011100	00000000	
FREE_FALL	R/W	5D	01011101	00000000	
MD1_CFG	R/W	5E	01011110	00000000	
MD2_CFG	R/W	5F	01011111	00000000	
RESERVED	-	60-61		00000000	Reserved
I3C_BUS_AVB	R/W	62	01100010	00000000	
INTERNAL_FREQ_FINE	R	63	01100011	output	
RESERVED	-	64-72			Reserved
X_OFS_USR	R/W	73	01110011	00000000	
Y_OFS_USR	R/W	74	01110100	00000000	
Z_OFS_USR	R/W	75	01110101	00000000	
RESERVED	-	76-77			Reserved
FIFO_DATA_OUT_TAG	R	78	01111000	output	

Name	Type	Register address		Default	Comment
		Hex	Binary		
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_Z_H	R	7E	01111110	output	

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

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 data through the serial interface.

9.1 FUNC_CFG_ACCESS (01h)

Enable embedded functions register (R/W)

Table 20. FUNC_CFG_ACCESS register

FUNC_CFG_ACCESS	0 ⁽¹⁾	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 21. FUNC_CFG_ACCESS register description

FUNC_CFG_ACCESS	Enable access to the embedded functions configuration registers. Default value: 0 ⁽¹⁾
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1. Details concerning the embedded functions configuration registers are available in [Section 10 Embedded functions register mapping](#) and [Section 11 Embedded functions register description](#).

9.2 PIN_CTRL (02h)

Enable/disable SDO pin pull-up register (R/W)

Table 22. PIN_CTRL register

0 ⁽¹⁾	SDO_PU_EN	1 ⁽²⁾	1 ⁽²⁾	1 ⁽²⁾	1 ⁽²⁾	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 23. PIN_CTRL register description

SDO_PU_EN	Enable pull-up on SDO pin. Default value: 0 (0: SDO pin pull-up disconnected (default); 1: SDO pin with pull-up)
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9.3 FIFO_CTRL1 (07h)

FIFO control register 1 (R/W)

Table 24. FIFO_CTRL1 register

WTM7	WTM6	WTM5	WTM4	WTM3	WTM2	WTM1	WTM0
------	------	------	------	------	------	------	------

Table 25. FIFO_CTRL1 register description

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

9.4 FIFO_CTRL2 (08h)

FIFO control register 2 (R/W)

Table 26. FIFO_CTRL2 register

STOP_ON_WTM	0 ⁽¹⁾	0 ⁽¹⁾	ODRCHG_EN	0 ⁽¹⁾	0 ⁽¹⁾	0 ⁽¹⁾	WTM8
-------------	------------------	------------------	-----------	------------------	------------------	------------------	------

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

Table 27. FIFO_CTRL2 register

STOP_ON_WTM	<p>Sensing chain FIFO stop values memorization at threshold level</p> <p>(0: FIFO depth is not limited (default);</p> <p>1: FIFO depth is limited to the threshold level, defined in FIFO_CTRL1 (07h) and FIFO_CTRL2 (08h)</p>
ODRCHG_EN	Enables ODR CHANGE virtual sensor to be batched in FIFO
WTM8	<p>FIFO watermark threshold, in conjunction with WTM[7:0] in FIFO_CTRL1 (07h)</p> <p>1 LSB = 1 sensor (6 bytes) + TAG (1 byte) written in FIFO</p> <p>Watermark flag rises when the number of bytes written in FIFO is greater than or equal to the threshold level.</p>

9.5 FIFO_CTRL3 (09h)

FIFO control register 3 (R/W)

Table 28. 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 29. FIFO_CTRL3 register description

BDR_GY_[3:0]	<p>Selects batch data rate (write frequency in FIFO) for gyroscope data.</p> <p>(0000: gyroscope not batched in FIFO (default);</p> <p>0001: 12.5 Hz;</p> <p>0010: 26 Hz;</p> <p>0011: 52 Hz;</p> <p>0100: 104 Hz;</p> <p>0101: 208 Hz;</p> <p>0110: 417 Hz;</p> <p>0111: 833 Hz;</p> <p>1000: 1667 Hz;</p> <p>1001: reserved;</p> <p>1010: reserved;</p> <p>1011: 6.5 Hz;</p> <p>1100-1111: reserved)</p>
BDR_XL_[3:0]	<p>Selects batch data rate (write frequency in FIFO) for accelerometer data.</p> <p>(0000: accelerometer not batched in FIFO (default);</p> <p>0001: 12.5 Hz;</p> <p>0010: 26 Hz;</p> <p>0011: 52 Hz;</p> <p>0100: 104 Hz;</p> <p>0101: 208 Hz;</p> <p>0110: 417 Hz;</p> <p>0111: 833 Hz;</p> <p>1000: 1667 Hz;</p> <p>1001: reserved;</p> <p>1010: reserved;</p> <p>1011: 1.6 Hz;</p> <p>1100-1111: reserved)</p>

9.6 FIFO_CTRL4 (0Ah)

FIFO control register 4 (R/W)

Table 30. FIFO_CTRL4 register

DEC_TS_BATCH_1	DEC_TS_BATCH_0	ODR_T_BATCH_1	ODR_T_BATCH_0	0 ⁽¹⁾	FIFO_MODE2	FIFO_MODE1	FIFO_MODE0
----------------	----------------	---------------	---------------	------------------	------------	------------	------------

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

Table 31. FIFO_CTRL4 register description

DEC_TS_BATCH_[1:0]	Selects decimation for timestamp batching in FIFO. The write rate is the maximum rate between the accelerometer and gyroscope BDR divided by decimation decoder. (00: timestamp not batched in FIFO (default); 01: decimation 1: $\max(\text{BDR_XL}[\text{Hz}], \text{BDR_GY}[\text{Hz}])$ [Hz]; 10: decimation 8: $\max(\text{BDR_XL}[\text{Hz}], \text{BDR_GY}[\text{Hz}])/8$ [Hz]; 11: decimation 32: $\max(\text{BDR_XL}[\text{Hz}], \text{BDR_GY}[\text{Hz}])/32$ [Hz])
ODR_T_BATCH_[1:0]	Selects batch data rate (write frequency in FIFO) for temperature data (00: temperature not batched in FIFO (default); 01: 1.6 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 32. COUNTER_BDR_REG1 register

dataready_pulsed	RST_COUNTER_BDR	TRIG_COUNTER_BDR	0 ⁽¹⁾	0 ⁽¹⁾	CNT_BDR_TH_10	CNT_BDR_TH_9	CNT_BDR_TH_8
------------------	-----------------	------------------	------------------	------------------	---------------	--------------	--------------

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

Table 33. 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 batch 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 batch events between the accelerometer and gyroscope. (0: accelerometer batch event; 1: gyroscope batch 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 batch 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 34. 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 35. 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 batch 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.
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9.9 INT1_CTRL (0Dh)

INT1 pin control register (R/W)

Each bit in this register enables a signal to be carried over INT1 when the MIPI I3CSM dynamic address is not assigned (I²C or SPI is used). Some bits can be also used to trigger an IBI (in-band interrupt) when the MIPI I3CSM interface is used. The output of the pad is the OR combination of the signals selected here and in register MD1_CFG (5Eh).

Table 36. 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 37. 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. It can be also used to trigger an IBI when the MIPI I3C SM interface is used.
INT1_FIFO_OVR	Enables FIFO overrun interrupt on INT1 pin. It can be also used to trigger an IBI when the MIPI I3C SM interface is used.
INT1_FIFO_TH	Enables FIFO threshold interrupt on INT1 pin. It can be also used to trigger an IBI when the MIPI I3C SM interface is used.
INT1_BOOT	Enables boot status on INT1 pin.
INT1_DRDY_G	Enables gyroscope data-ready interrupt on INT1 pin. It can be also used to trigger an IBI when the MIPI I3C SM interface is used.
INT1_DRDY_XL	Enables accelerometer data-ready interrupt on INT1 pin. It can be also used to trigger an IBI when the MIPI I3C SM interface is used.

9.10 INT2_CTRL (0Eh)

INT2 pin control register (R/W)

Each bit in this register enables a signal to be carried over INT2 when the MIPI I3CSM dynamic address is not assigned (I²C or SPI is used). Some bits can be also used to trigger an IBI when the MIPI I3CSM interface is used. The output of the pad is the OR combination of the signals selected here and in register MD2_CFG (5Fh).

Table 38. INT2_CTRL register

0 ⁽¹⁾	INT2_CNT_BDR	INT2_FIFO_FULL	INT2_FIFO_OVR	INT2_FIFO_TH	INT2_DRDY_TEMP	INT2_DRDY_G	INT2_DRDY_XL
------------------	--------------	----------------	---------------	--------------	----------------	-------------	--------------

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

Table 39. INT2_CTRL register description

INT2_CNT_BDR	Enables COUNTER_BDR_IA interrupt on INT2 pin.
INT2_FIFO_FULL	Enables FIFO full flag interrupt on INT2 pin.
INT2_FIFO_OVR	Enables FIFO overrun interrupt on INT2 pin.
INT2_FIFO_TH	Enables FIFO threshold interrupt on INT2 pin.
INT2_DRDY_TEMP	Enables temperature sensor data-ready interrupt on INT2 pin. It can be also used to trigger an IBI when the MIPI I3C SM interface is used and INT2_ON_INT1 = 1 in CTRL4_C (13h).
INT2_DRDY_G	Enables gyroscope data-ready interrupt on INT2 pin.
INT2_DRDY_XL	Enables 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 40. Who_Am_I register

0	1	1	0	1	0	1	1
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9.12 CTRL1_XL (10h)

Accelerometer control register 1 (R/W)

Table 41. CTRL1_XL register

ODR_XL3	ODR_XL2	ODR_XL1	ODR_XL0	FS1_XL	FS0_XL	LPF2_XL_EN	0 ⁽¹⁾
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1. This bit must be set to 0 for the correct operation of the device.

Table 42. CTRL1_XL register description

ODR_XL[3:0]	Accelerometer ODR selection (see Table 43)
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 43. 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)	N.A.
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 (low power)	104 Hz (high performance)
0	1	0	1	208 Hz (low power)	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	1.67 kHz (high performance)	1.67 kHz (high performance)
1	0	0	1	Reserved	Reserved
1	0	1	0	Reserved	Reserved
1	1	x	x	Reserved	Reserved

9.13 CTRL2_G (11h)

Gyroscope control register 2 (R/W)

Table 44. CTRL2_G register

ODR_G3	ODR_G2	ODR_G1	ODR_G0	FS1_G	FS0_G	FS_125	FS_4000
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Table 45. CTRL2_G register description

ODR_G[3:0]	Gyroscope output data rate selection. Default value: 0000 (Refer to Table 46)
FS[1:0]_G	Gyroscope chain full-scale selection (00: ± 250 dps; 01: ± 500 dps; 10: ± 1000 dps; 11: ± 2000 dps)
FS_125	Selects gyroscope chain full-scale ± 125 dps (0: FS selected through bits FS[1:0]_G; 1: FS set to ± 125 dps)
FS_4000	Selects gyroscope chain full-scale ± 4000 dps (0: FS selected through bits FS[1:0]_G or FS_125; 1: FS set to ± 4000 dps)

Table 46. Gyroscope ODR configuration setting

ODR_G3	ODR_G2	ODR_G1	ODR_G0	ODR selection [Hz] when G_HM_MODE = 1 in CTRL7_G (16h)	ODR selection [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 (low power)	104 Hz (high performance)
0	1	0	1	208 Hz (low power)	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	1.67 kHz (high performance)	1.67 kHz (high performance)
1	0	0	1	Reserved	Reserved
1	0	1	0	Reserved	Reserved
1	0	1	1	Reserved	Reserved

9.14 CTRL3_C (12h)

Control register 3 (R/W)

Table 47. CTRL3_C register

BOOT	BDU	H_LACTIVE	PP_OD	SIM	IF_INC	0 ⁽¹⁾	SW_RESET
------	-----	-----------	-------	-----	--------	------------------	----------

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

Table 48. CTRL3_C register description

BOOT	Reboots memory content. Default value: 0 (0: normal mode; 1: reboot memory content) Note: the accelerometer must be ON. 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. This bit must be set to 0 when H_LACTIVE is set to 1. 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 ² C 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 49. CTRL4_C register

0 ⁽¹⁾	SLEEP_G	INT2_on_INT1	0 ⁽¹⁾	DRDY_MASK	I2C_disable	LPF1_SEL_G	0 ⁽¹⁾
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1. This bit must be set to 0 for the correct operation of the device.

Table 50. 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 accelerometer and gyroscope) until filter settling ends (accelerometer and gyroscope independently masked).
I2C_disable	Disables I ² C interface. Default value: 0 (0: SPI, I ² C and MIPI I3C SM interfaces enabled (default); 1: I ² C interface disabled)
LPF1_SEL_G	Enables gyroscope digital LPF1; 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 51. CTRL5_C register

0 ⁽¹⁾	ROUNDING1	ROUNDING0	0 ⁽¹⁾	ST1_G	ST0_G	ST1_XL	ST0_XL
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1. This bit must be set to 0 for the correct operation of the device.

Table 52. CTRL5_C register description

ROUNDING[1:0]	Circular burst-mode (rounding) read of the output registers. Default value: 00 (00: no rounding; 01: accelerometer only; 10: gyroscope only; 11: gyroscope + accelerometer)
ST[1:0]_G	Enables angular rate sensor self-test. Default value: 00 (00: self-test disabled; Other: refer to Table 53)
ST[1:0]_XL	Enables linear acceleration sensor self-test. Default value: 00 (00: self-test disabled; Other: refer to Table 54)

Table 53. 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 54. 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 55. CTRL6_C register

TRIG_EN	LVL1_EN	LVL2_EN	XL_HM_MODE	USR_OFF_W	FTYPE_2	FTYPE_1	FTYPE_0
---------	---------	---------	------------	-----------	---------	---------	---------

Table 56. CTRL6_C register description

TRIG_EN	Enables DEN data edge-sensitive trigger mode. Refer to Table 57.
LVL1_EN	Enables DEN data level-sensitive trigger mode. Refer to Table 57.
LVL2_EN	Enables DEN level-sensitive latched mode. Refer to Table 57.
XL_HM_MODE	Disables high-performance operating mode 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 low-pass filter (LPF1) bandwidth selection. Table 58 shows the selectable bandwidth values.

Table 57. 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 58. 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
000	4.3	8.3	16.7	33	67	133	222	274
001	4.3	8.3	16.7	33	67	128	186	212
010	4.3	8.3	16.7	33	67	112	140	150
011	4.3	8.3	16.7	33	67	134	260	390
100	4.3	8.3	16.7	34	62	86	96	99
101	4.3	8.3	16.9	31	43	48	49	50
110	4.3	8.3	13.4	19	23	24.6	25	25
111	4.3	8.3	9.8	11.6	12.2	12.4	12.6	12.6

9.18 CTRL7_G (16h)

Control register 7 (R/W)

Table 59. CTRL7_G register

G_HM_MODE	HP_EN_G	HPM1_G	HPM0_G	0 ⁽¹⁾	0 ⁽¹⁾	USR_OFF_ON_OUT	0 ⁽¹⁾
-----------	---------	--------	--------	------------------	------------------	----------------	------------------

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

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 gyroscope 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)
USR_OFF_ON_OUT	Enables accelerometer user offset correction block; it's valid for the low-pass path - see Figure 20 . Default value: 0 (0: accelerometer user offset correction block bypassed; 1: accelerometer user offset correction block enabled)

9.19 CTRL8_XL (17h)

Control register 8 (R/W)

Table 60. 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
-----------	-----------	-----------	----------------	-------------------	----------------	------------------	----------------

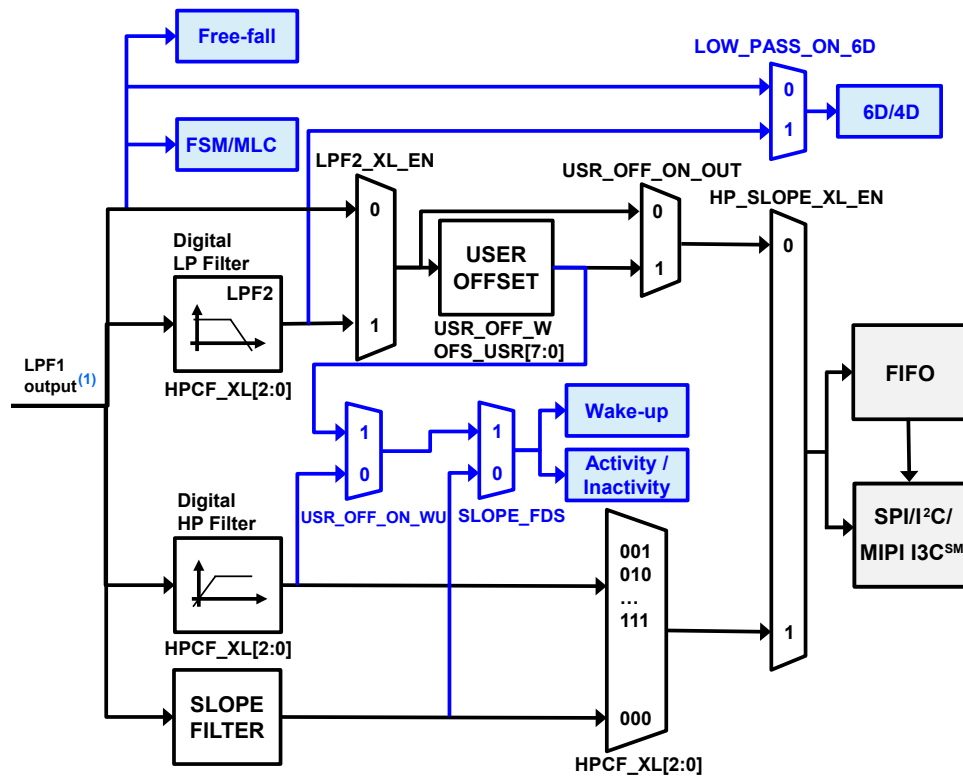
1. This bit must be set to 0 for the correct operation of the device.

HPCF_XL[2:0]	Accelerometer LPF2 and HP filter configuration and cutoff setting. Refer to Table 61 .
HP_REF_MODE_XL	Enables accelerometer high-pass filter reference mode (valid for high-pass path - HP_SLOPE_XL_EN bit must be 1). Default value: 0 ⁽¹⁾ (0: disabled, 1: enabled)
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 22 .
LOW_PASS_ON_6D	LPF2 on 6D function selection. Refer to Figure 22 . 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 61. Accelerometer bandwidth configurations

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

Figure 22. 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 mode.

9.20 CTRL9_XL (18h)

Control register 9 (R/W)

Table 62. CTRL9_XL register

DEN_X	DEN_Y	DEN_Z	DEN_XL_G	DEN_XL_EN	DEN_LH	I3C_disable	0 ⁽¹⁾
-------	-------	-------	----------	-----------	--------	-------------	------------------

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

Table 63. 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)
I3C_disable	Disables MIPI I3C SM communication protocol ⁽¹⁾ (0: SPI, I ² C, MIPI I3C SM interfaces enabled (default); 1: MIPI I3C SM interface disabled)

1. It is recommended to set this bit to 1 during the initial device configuration phase, when the I3C interface is not used.

9.21 CTRL10_C (19h)

Control register 10 (R/W)

Table 64. CTRL10_C register

0 ⁽¹⁾	0 ⁽¹⁾	TIMESTAMP_EN	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 65. 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 66. ALL_INT_SRC register

TIMESTAMP_ENDCOUNT	0	SLEEP_CHANGE_IA	D6D_IA	0	0	WU_IA	FF_IA
--------------------	---	-----------------	--------	---	---	-------	-------

Table 67. 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)
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 68. WAKE_UP_SRC register

0	SLEEP_CHANGE_IA	FF_IA	SLEEP_STATE	WU_IA	X_WU	Y_WU	Z_WU
---	-----------------	-------	-------------	-------	------	------	------

Table 69. 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	Wake-up event detection status. Default value: 0 (0: wake-up event not detected; 1: wake-up event detected.)
X_WU	Wake-up event detection status on X-axis. Default value: 0 (0: wake-up event on X-axis not detected; 1: wake-up event on X-axis detected)
Y_WU	Wake-up event detection status on Y-axis. Default value: 0 (0: wake-up event on Y-axis not detected; 1: wake-up event on Y-axis detected)
Z_WU	Wake-up event detection status on Z-axis. Default value: 0 (0: wake-up event on Z-axis not detected; 1: wake-up event on Z-axis detected)

9.24 DRD_SRC (1Dh)

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

Table 70. D6D_SRC register

DEN_DRDY	D6D_IA	ZH	ZL	YH	YL	XH	XL
----------	--------	----	----	----	----	----	----

Table 71. 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.

9.25 STATUS_REG (1Eh)

Status register (R)

Table 72. STATUS_REG register

0	0	0	0	BOOT_CHECK_FAIL	TDA	GDA	XLDA
---	---	---	---	-----------------	-----	-----	------

Table 73. STATUS_REG register description

BOOT_CHECK_FAIL	Embedded CRC check status after boot/reboot. Default value: 0 (0: boot check passed; 1: boot check failed)
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)

9.26 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 74. OUT_TEMP_L register

Temp7	Temp6	Temp5	Temp4	Temp3	Temp2	Temp1	Temp0
-------	-------	-------	-------	-------	-------	-------	-------

Table 75. OUT_TEMP_H register

Temp15	Temp14	Temp13	Temp12	Temp11	Temp10	Temp9	Temp8
--------	--------	--------	--------	--------	--------	-------	-------

Table 76. OUT_TEMP register description

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

9.27 OUTX_H_C (23h), OUTX_L_G (22h)

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

Table 77. OUTX_H_G register

D15	D14	D13	D12	D11	D10	D9	D8
-----	-----	-----	-----	-----	-----	----	----

Table 78. OUTX_L_G register

D7	D6	D5	D4	D3	D2	D1	D0
----	----	----	----	----	----	----	----

Table 79. OUTX_H_G, OUTX_L_G register description

D[15:0]	Gyroscope pitch axis output expressed in two's complement
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9.28 OUTY_H_G (25h), OUTY_L_G (24h)

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

Table 80. OUTY_H_G register

D15	D14	D13	D12	D11	D10	D9	D8
-----	-----	-----	-----	-----	-----	----	----

Table 81. OUTY_L_G register

D7	D6	D5	D4	D3	D2	D1	D0
----	----	----	----	----	----	----	----

Table 82. OUTY_H_G, OUTY_L_G register description

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

9.29 OUTZ_H_G (27h), OUTZ_L_G (26h)

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

Table 83. OUTZ_H_G register

D15	D14	D13	D12	D11	D10	D9	D8
-----	-----	-----	-----	-----	-----	----	----

Table 84. OUTZ_L_G register

D7	D6	D5	D4	D3	D2	D1	D0
----	----	----	----	----	----	----	----

Table 85. OUTZ_H_G, OUTZ_L_G register description

D[15:0]	Gyroscope yaw axis output expressed in two's complement
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9.30 OUTX_H_A (29h), OUTX_L_A (28h)

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

Table 86. OUTX_H_A register

D15	D14	D13	D12	D11	D10	D9	D8
-----	-----	-----	-----	-----	-----	----	----

Table 87. OUTX_L_A register

D7	D6	D5	D4	D3	D2	D1	D0
----	----	----	----	----	----	----	----

Table 88. OUTX_H_A, OUTX_L_A register description

D[15:0]	Accelerometer X-axis output expressed as two's complement
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9.31 OUTY_H_A (2Bh), OUTY_L_A (2Ah)

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

Table 89. OUTY_H_A register

D15	D14	D13	D12	D11	D10	D9	D8
-----	-----	-----	-----	-----	-----	----	----

Table 90. OUTY_L_A register

D7	D6	D5	D4	D3	D2	D1	D0
----	----	----	----	----	----	----	----

Table 91. OUTY_H_A, OUTY_L_A register description

D[15:0]	Accelerometer Y-axis output expressed as two's complement
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9.32 OUTZ_H_A (2Dh), OUTZ_L_A (2Ch)

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

Table 92. OUTZ_H_A register

D15	D14	D13	D12	D11	D10	D9	D8
-----	-----	-----	-----	-----	-----	----	----

Table 93. OUTZ_L_A register

D7	D6	D5	D4	D3	D2	D1	D0
----	----	----	----	----	----	----	----

Table 94. OUTZ_H_A, OUTZ_L_A register description

D[15:0]	Accelerometer Z-axis output expressed as two's complement
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9.33 EMB_FUNC_STATUS_MAINPAGE (35h)

Embedded function status register (R)

Table 95. EMB_FUNC_STATUS_MAINPAGE register

IS_FSM_LC	0	0	0	0	0	0	0
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Table 96. 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)
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9.34 FSM_STATUS_A_MAINPAGE (36h)

Finite state machine status register (R)

Table 97. FSM_STATUS_A_MAINPAGE register

IS_FSM8	IS_FSM7	IS_FSM6	IS_FSM5	IS_FSM4	IS_FSM3	IS_FSM2	IS_FSM1
---------	---------	---------	---------	---------	---------	---------	---------

Table 98. 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)

9.35 FSM_STATUS_B_MAINPAGE (37h)

Finite state machine status register (R)

Table 99. FSM_STATUS_B_MAINPAGE register

IS_FSM16	IS_FSM15	IS_FSM14	IS_FSM13	IS_FSM12	IS_FSM11	IS_FSM10	IS_FSM9
----------	----------	----------	----------	----------	----------	----------	---------

Table 100. 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)

9.36 MLC_STATUS_MAINPAGE (38h)

Machine learning core status register (R)

Table 101. MLC_STATUS_MAINPAGE register

IS_MLC8	IS_MLC7	IS_MLC6	IS_MLC5	IS_MLC4	IS_MLC3	IS_MLC2	IS_MLC1
---------	---------	---------	---------	---------	---------	---------	---------

Table 102. 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)

9.37 FIFO_STATUS1 (3Ah)

FIFO status register 1 (R)

Table 103. 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 104. 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).
-----------------	--

9.38 FIFO_STATUS2 (3Bh)

FIFO status register 2 (R)

Table 105. FIFO_STATUS2 register

FIFO_WTM_IA	FIFO_OVR_IA	FIFO_FULL_IA	COUNTER_BDR_IA	FIFO_OVR_LATCHED	0	DIFF_FIFO_9	DIFF_FIFO_8
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Table 106. 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)

9.39 **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 107. TIMESTAMP3 register

D31	D30	D29	D28	D27	D26	D25	D24
-----	-----	-----	-----	-----	-----	-----	-----

Table 108. TIMESTAMP2 register

D23	D22	D21	D20	D19	D18	D17	D16
-----	-----	-----	-----	-----	-----	-----	-----

Table 109. TIMESTAMP1 register

D15	D14	D13	D12	D11	D10	D9	D8
-----	-----	-----	-----	-----	-----	----	----

Table 110. TIMESTAMP0 register

D7	D6	D5	D4	D3	D2	D1	D0
----	----	----	----	----	----	----	----

D[31:0]	Timestamp output registers: 1LSB = 25 μs
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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 \(63h\)](#).

9.40 INT_CFG0 (56h)

Activity/inactivity functions, configuration of filtering, and interrupt latch mode configuration (R/W)

Table 111. INT_CFG0 register

0 ⁽¹⁾	INT_CLR_ON_READ	SLEEP_STATUS_ON_INT	SLOPE_FDS	0 ⁽¹⁾	0 ⁽¹⁾	0 ⁽¹⁾	LIR
------------------	-----------------	---------------------	-----------	------------------	------------------	------------------	-----

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

Table 112. INT_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 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)
LIR	Latched interrupt. Default value: 0 (0: interrupt request not latched; 1: interrupt request latched)

9.41 INT_CFG1 (58h)

Enable interrupt function register (R/W)

Table 113. INT_CFG1 register

INTERRUPTS_ENABLE	INACT_EN1	INACT_EN0	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 114. INT_CFG1 register description

INTERRUPTS_ENABLE	Enables hardcoded functions
INACT_EN[1:0]	Enables activity/inactivity (sleep) function. Default value: 00 (00: stationary/motion-only interrupts generated, accelerometer and gyroscope do not change; 01: sets accelerometer ODR to 12.5 Hz (low-power mode), gyroscope does not change; 10: sets accelerometer ODR to 12.5 Hz (low-power mode), gyroscope to sleep mode; 11: sets accelerometer ODR to 12.5 Hz (low-power mode), gyroscope to power-down mode)

9.42 THS_6D (59h)

Portrait/landscape position register (R/W)

Table 115. THS_6D register

D4D_EN	SIXD_THS1	SIXD_THS0	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 116. THS_6D register description

D4D_EN	Enables detection of 4D orientation. Z-axis position detection is disabled. Default value: 0 (0: disabled; 1: enabled)
SIXD_THS[1:0]	Threshold for 4D/6D function (00: 80 degrees (default); 01: 70 degrees; 10: 60 degrees; 11: 50 degrees)

9.43 WAKE_UP_THS (5Bh)

Wake-up configuration register (R/W)

Table 117. WAKE_UP_THS register

0 ⁽¹⁾	USR_OFF_ON_WU	WK_THS5	WK_THS4	WK_THS3	WK_THS2	WK_THS1	WK_THS0
------------------	---------------	---------	---------	---------	---------	---------	---------

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

Table 118. WAKE_UP_THS register description

USR_OFF_ON_WU	Sends the low-pass filtered data with user offset correction (instead of high-pass filtered data) to the wake-up and the activity/inactivity functions. Default value: 0
WK_THS[5:0]	Threshold for wake-up: 1 LSB weight depends on WAKE_THS_W in WAKE_UP_DUR (5Ch). Default value: 000000

9.44 WAKE_UP_DUR (5Ch)

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

Table 119. WAKE_UP_DUR register

FF_DUR5	WAKE_DUR1	WAKE_DUR0	WAKE_THS_W	SLEEP_DUR3	SLEEP_DUR2	SLEEP_DUR1	SLEEP_DUR0
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Table 120. 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 wake-up 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

9.45 FREE_FALL (5Dh)

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

Table 121. FREE_FALL register

FF_DUR4	FF_DUR3	FF_DUR2	FF_DUR1	FF_DUR0	FF_THS2	FF_THS1	FF_THS0
---------	---------	---------	---------	---------	---------	---------	---------

Table 122. 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 (000: 156 mg (default); 001: 219 mg; 010: 250 mg; 011: 312 mg; 100: 344 mg; 101: 406 mg; 110: 469 mg; 111: 500 mg)

9.46 MD1_CFG (5Eh)

Functions routing to INT1 pin register (R/W)

Table 123. MD1_CFG register

INT1_SLEEP_CHANGE	0 ⁽¹⁾	INT1_WU	INT1_FF	0 ⁽¹⁾	INT1_6D	INT1_EMB_FUNC	0 ⁽¹⁾
-------------------	------------------	---------	---------	------------------	---------	---------------	------------------

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

Table 124. MD1_CFG register description

INT1_SLEEP_CHANGE ⁽¹⁾	Routing activity/inactivity recognition event to INT1. Default: 0 (0: routing activity/inactivity event to INT1 disabled; 1: routing activity/inactivity event to INT1 enabled)
INT1_WU	Routing wake-up event to INT1. Default value: 0 (0: routing wake-up event to INT1 disabled; 1: routing wake-up event to INT1 enabled)
INT1_FF	Routing free-fall event to INT1. Default value: 0 (0: routing free-fall event to INT1 disabled; 1: routing free-fall event to INT1 enabled)
INT1_6D	Routing 6D event to INT1. Default value: 0 (0: routing 6D event to INT1 disabled; 1: routing 6D event to INT1 enabled)
INT1_EMB_FUNC	Routing embedded functions event to INT1. Default value: 0 (0: routing embedded functions event to INT1 disabled; 1: routing embedded functions event to INT1 enabled)

1. Activity/inactivity interrupt mode (sleep change or sleep status) depends on the SLEEP_STATUS_ON_INT bit in the INT_CFG0 (56h) register.

9.47 MD2_CFG (5Fh)

Functions routing to INT2 pin register (R/W)

Table 125. MD2_CFG register

INT2_SLEEP_CHANGE	0 ⁽¹⁾	INT2_WU	INT2_FF	0 ⁽¹⁾	INT2_6D	INT2_EMB_FUNC	INT2_TIMESTAMP
-------------------	------------------	---------	---------	------------------	---------	---------------	----------------

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

Table 126. MD2_CFG register description

INT2_SLEEP_CHANGE ⁽¹⁾	Routing activity/inactivity recognition event to INT2. Default: 0 (0: routing activity/inactivity event to INT2 disabled; 1: routing activity/inactivity event to INT2 enabled)
INT2_WU	Routing wake-up event to INT2. Default value: 0 (0: routing wake-up event to INT2 disabled; 1: routing wake-up event to INT2 enabled)
INT2_FF	Routing free-fall event to INT2. Default value: 0 (0: routing free-fall event to INT2 disabled; 1: routing free-fall event to INT2 enabled)
INT2_6D	Routing 6D event to INT2. Default value: 0 (0: routing 6D event to INT2 disabled; 1: routing 6D event to INT2 enabled)
INT2_EMB_FUNC	Routing embedded functions event to INT2. Default value: 0 (0: routing embedded functions event to INT2 disabled; 1: routing embedded functions event to INT2 enabled)
INT2_TIMESTAMP	Enables routing to 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 the INT_CFG0 (56h) register.

9.48 I3C_BUS_AVB (62h)

I3C_BUS_AVB register (R/W)

Table 127. I3C_BUS_AVB register

0 ⁽¹⁾	0 ⁽¹⁾	0 ⁽¹⁾	I3C_Bus_Avb_Sel1	I3C_Bus_Avb_Sel0	0 ⁽¹⁾	0 ⁽¹⁾	PD_DIS_INT1
------------------	------------------	------------------	------------------	------------------	------------------	------------------	-------------

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

Table 128. I3C_BUS_AVB register description

I3C_Bus_Avb_Sel[1:0]	<p>These bits are used to select the bus available time when I3C IBI is used.</p> <p>Default value: 00</p> <p>(00: bus available time equal to 50 μs (default);</p> <p>01: bus available time equal to 2 μs;</p> <p>10: bus available time equal to 1 ms;</p> <p>11: bus available time equal to 25 ms)</p>
PD_DIS_INT1	<p>This bit allows disabling the INT1 pull-down.</p> <p>(0: Pull-down on INT1 enabled (pull-down is effectively connected only when no interrupts are routed to the INT1 pin or when the I3C dynamic address is assigned);</p> <p>1: Pull-down on INT1 disabled (pull-down not connected))</p>

Note: *The IBI (in-band interrupt) is continuously generated (each time a bus available condition is satisfied) until an interrupt is served. The master should execute the interrupt service routine (ISR) at a time lower than the configured bus available time, otherwise the master should disable the interrupt (I3C DISEC in order to disable the interrupt request) at a time lower than the bus available time.*

If the master needs more time to analyze and start the correct ISR, then the master can change the bus available time from 50 μ s (default) to a higher time.

9.49 INTERNAL_FREQ_FINE (63h)

Internal frequency register (R)

Table 129. INTERNAL_FREQ_FINE register

FREQ_FINE7	FREQ_FINE6	FREQ_FINE5	FREQ_FINE4	FREQ_FINE3	FREQ_FINE2	FREQ_FINE1	FREQ_FINE0
------------	------------	------------	------------	------------	------------	------------	------------

Table 130. 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, two's complement.
----------------	--

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

$$\text{ODR_Actual} = (6667 + ((0.0015 * \text{INTERNAL_FREQ_FINE}) * 6667)) / \text{ODR_Coeff}$$

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

The Selected_ODR parameter has to be derived from the ODR_XL selection ([Table 42. CTRL1_XL register description](#)) in order to estimate the accelerometer ODR and from the ODR_G selection ([Table 45. CTRL2_G register description](#)) in order to estimate the gyroscope ODR.

9.50 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 131. 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 132. 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].
-----------------	---

9.51 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 133. 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
-------------	-------------	-------------	-------------	-------------	-------------	-------------	-------------

Y_OFS_USR_[7:0]	Accelerometer Y-axis user offset calibration expressed in two's complement, weight depends on USR_OFF_W in CTRL6_C (15h). The value must be in the range [-127, +127].
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9.52 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 134. 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 135. Z_OFS_USR register description

Z_OFS_USR_[7:0]	Accelerometer Z-axis user offset calibration expressed in two's complement, weight depends on USR_OFF_W in CTRL6_C (15h). The value must be in the range [-127, +127].
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9.53 FIFO_DATA_OUT_TAG (78h)

FIFO tag register (R)

Table 136. 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
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Table 137. FIFO_DATA_OUT_TAG register description

TAG_SENSOR_[4:0]	Identifies the sensor in: FIFO_DATA_OUT_X_H (7Ah) and FIFO_DATA_OUT_X_L (79h), FIFO_DATA_OUT_Y_H (7Ch) and FIFO_DATA_OUT_Y_L (7Bh), and FIFO_DATA_OUT_Z_H (7Eh) and FIFO_DATA_OUT_Z_L (7Dh)
TAG_CNT_[1:0]	2-bit counter which identifies sensor time slot
TAG_PARITY	Parity check of TAG content

Table 138. FIFO tag

TAG_SENSOR_[4:0]	Sensor name
0x01	Gyroscope
0x02	Accelerometer
0x03	Temperature
0x04	Timestamp
0x05	CFG_Change

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

FIFO data output X (R)

Table 139. FIFO_DATA_OUT_X_H register

D15	D14	D13	D12	D11	D10	D9	D8
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Table 140. FIFO_DATA_OUT_X_L register

D7	D6	D5	D4	D3	D2	D1	D0
----	----	----	----	----	----	----	----

Table 141. FIFO_DATA_OUT_X_H, FIFO_DATA_OUT_X_L register description

D[15:0]	FIFO X-axis output
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9.55 FIFO_DATA_OUT_Y_H (7Ch) and FIFO_DATA_OUT_Y_L (7Bh)

FIFO data output Y (R)

Table 142. FIFO_DATA_OUT_Y_H register

D15	D14	D13	D12	D11	D10	D9	D8
-----	-----	-----	-----	-----	-----	----	----

Table 143. FIFO_DATA_OUT_Y_L register

D7	D6	D5	D4	D3	D2	D1	D0
----	----	----	----	----	----	----	----

Table 144. FIFO_DATA_OUT_Y_H, FIFO_DATA_OUT_Y_L register description

D[15:0]	FIFO Y-axis output
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9.56 FIFO_DATA_OUT_Z_H (7Eh) and FIFO_DATA_OUT_Z_L (7Dh)

FIFO data output Z (R)

Table 145. FIFO_DATA_OUT_Z_H register

D15	D14	D13	D12	D11	D10	D9	D8
-----	-----	-----	-----	-----	-----	----	----

Table 146. FIFO_DATA_OUT_Z_L register

D7	D6	D5	D4	D3	D2	D1	D0
----	----	----	----	----	----	----	----

Table 147. FIFO_DATA_OUT_Z_H, FIFO_DATA_OUT_Z_L register description

D[15:0]	FIFO Z-axis output
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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 148. Register address map - embedded functions

Name	Type	Register address		Default	Comment
		Hex	Binary		
PAGE_SEL	R/W	02	00000010	00000001	
RESERVED	-	03-04			Reserved
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	0F	00001111	01101011	
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	-	18-45			Reserved
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	
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	

Name	Type	Register address		Default	Comment
		Hex	Binary		
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	-	5C-5E			Reserved
EMB_FUNC_ODR_CFG_B	R/W	5F	01011111	01001011	
EMB_FUNC_ODR_CFG_C	R/W	60	01100000	00010101	
RESERVED	-	61-66			Reserved
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	

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

11 Embedded functions register description

11.1 PAGE_SEL (02h)

Enable advanced features dedicated page (R/W)

Table 149. PAGE_SEL register

PAGE_SEL3	PAGE_SEL2	PAGE_SEL1	PAGE_SEL0	0 ⁽¹⁾	0 ⁽¹⁾	EMB_FUNC_CLK_DIS	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 150. PAGE_SEL register description

PAGE_SEL[3:0]	Selects the advanced features dedicated page. Default value: 0000
EMB_FUNC_CLK_DIS	Disables the embedded functions clock. Default value: 0 (0: clock enabled; 1: clock disabled)

11.2 EMB_FUNC_EN_B (05h)

Enable embedded functions register (R/W)

Table 151. EMB_FUNC_EN_B register

0 ⁽¹⁾	0 ⁽¹⁾	0 ⁽¹⁾	MLC_EN	0 ⁽¹⁾	0 ⁽¹⁾	0 ⁽¹⁾	FSM_EN
------------------	------------------	------------------	--------	------------------	------------------	------------------	--------

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

Table 152. EMB_FUNC_EN_B register description

MLC_EN	Enables machine learning core feature. Default value: 0 (0: machine learning core feature disabled; 1: machine learning core feature enabled)
FSM_EN	Enables finite state machine (FSM) feature. Default value: 0 (0: FSM feature disabled; 1: FSM feature enabled)

11.3 PAGE_ADDRESS (08h)

Page address register (R/W)

Table 153. PAGE_ADDRESS register

PAGE_ADDR7	PAGE_ADDR6	PAGE_ADDR5	PAGE_ADDR4	PAGE_ADDR3	PAGE_ADDR2	PAGE_ADDR1	PAGE_ADDR0
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Table 154. 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).
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11.4 PAGE_VALUE (09h)

Page value register (R/W)

Table 155. PAGE_VALUE register

PAGE_VALUE7	PAGE_VALUE6	PAGE_VALUE5	PAGE_VALUE4	PAGE_VALUE3	PAGE_VALUE2	PAGE_VALUE1	PAGE_VALUE0
-------------	-------------	-------------	-------------	-------------	-------------	-------------	-------------

Table 156. 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.
-----------------	--

11.5 EMB_FUNC_INT1 (0Ah)

INT1 pin control register (R/W)

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

Table 157. EMB_FUNC_INT1 register

INT1_FSM_LC	0 ⁽¹⁾	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 158. EMB_FUNC_INT1 register description

INT1_FSM_LC ⁽¹⁾	Routing FSM long counter timeout interrupt event to INT1. Default value: 0 (0: routing to INT1 disabled; 1: routing to INT1 enabled)
----------------------------	---

1. This bit is activated if the INT1_EMB_FUNC bit of [MD1_CFG \(5Eh\)](#) is set to 1.

11.6 FSM_INT1_A (0Bh)

INT1 pin control register (R/W)

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

Table 159. FSM_INT1_A register

INT1_FSM8	INT1_FSM7	INT1_FSM6	INT1_FSM5	INT1_FSM4	INT1_FSM3	INT1_FSM2	INT1_FSM1
-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------

Table 160. FSM_INT1_A register description

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

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

11.7 FSM_INT1_B (0Ch)

INT1 pin control register (R/W)

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

Table 161. FSM_INT1_B register

INT1_FSM16	INT1_FSM15	INT1_FSM14	INT1_FSM13	INT1_FSM12	INT1_FSM11	INT1_FSM10	INT1_FSM9
------------	------------	------------	------------	------------	------------	------------	-----------

Table 162. FSM_INT1_B register description

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

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

11.8 MLC_INT1 (0Dh)

INT1 pin control register (R/W)

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

Table 163. MLC_INT1 register

INT1_MLC8	INT1_MLC7	INT1_MLC6	INT1_MLC5	INT1_MLC4	INT1_MLC3	INT1_MLC2	INT1_MLC1
-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------

Table 164. MLC_INT1 register description

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

11.9 EMB_FUNC_INT2 (0Eh)

INT2 pin control register (R/W)

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

Table 165. EMB_FUNC_INT2 register

INT2_FSM_LC	0 ⁽¹⁾	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 166. EMB_FUNC_INT2 register description

INT2_FSM_LC ⁽¹⁾	Routing FSM long counter timeout interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
----------------------------	---

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

11.10 FSM_INT2_A (0Fh)

INT2 pin control register (R/W)

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

Table 167. FSM_INT2_A register

INT2_FSM8	INT2_FSM7	INT2_FSM6	INT2_FSM5	INT2_FSM4	INT2_FSM3	INT2_FSM2	INT2_FSM1
-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------

Table 168. FSM_INT2_A register description

INT2_FSM8 ⁽¹⁾	Routing FSM8 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM7 ⁽¹⁾	Routing FSM7 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM6 ⁽¹⁾	Routing FSM6 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM5 ⁽¹⁾	Routing FSM5 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM4 ⁽¹⁾	Routing FSM4 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM3 ⁽¹⁾	Routing FSM3 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled) (0: routing to INT1 disabled; 1: routing to INT1 enabled)
INT2_FSM2 ⁽¹⁾	Routing FSM2 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)
INT2_FSM1 ⁽¹⁾	Routing FSM1 interrupt event to INT2. Default value: 0 (0: routing to INT2 disabled; 1: routing to INT2 enabled)

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

11.11 FSM_INT2_B (10h)

INT2 pin control register (R/W)

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

Table 169. FSM_INT2_B register

INT2_FSM16	INT2_FSM15	INT2_FSM14	INT2_FSM13	INT2_FSM12	INT2_FSM11	INT2_FSM10	INT2_FSM9
------------	------------	------------	------------	------------	------------	------------	-----------

Table 170. FSM_INT2_B register description

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

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

11.12 MLC_INT2 (11h)

INT2 pin control register (R/W)

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

Table 171. MLC_INT2 register

INT2_MLC8	INT2_MLC7	INT2_MLC6	INT2_MLC5	INT2_MLC4	INT2_MLC3	INT2_MLC2	INT2_MLC1
-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------

Table 172. MLC_INT2 register description

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

11.13 EMB_FUNC_STATUS (12h)

Embedded function status register (R)

Table 173. EMB_FUNC_STATUS register

IS_FSM_LC	0	0	0	0	0	0	0
-----------	---	---	---	---	---	---	---

Table 174. EMB_FUNC_STATUS register description

IS_FSM_LC	Interrupt status bit for FSM long counter timeout interrupt event. (1: interrupt detected; 0: no interrupt)
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11.14 FSM_STATUS_A (13h)

Finite state machine status register (R)

Table 175. FSM_STATUS_A register

IS_FSM8	IS_FSM7	IS_FSM6	IS_FSM5	IS_FSM4	IS_FSM3	IS_FSM2	IS_FSM1
---------	---------	---------	---------	---------	---------	---------	---------

Table 176. 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)

11.15 FSM_STATUS_B (14h)

Finite state machine status register (R)

Table 177. FSM_STATUS_B register

IS_FSM16	IS_FSM15	IS_FSM14	IS_FSM13	IS_FSM12	IS_FSM11	IS_FSM10	IS_FSM9
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Table 178. 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)

11.16 MLC_STATUS (15h)

Machine learning core status register (R)

Table 179. MLC_STATUS register

IS_MLC8	IS_MLC7	IS_MLC6	IS_MLC5	IS_MLC4	IS_MLC3	IS_MLC2	IS_MLC1
---------	---------	---------	---------	---------	---------	---------	---------

Table 180. 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)

11.17 PAGE_RW (17h)

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

Table 181. 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 182. PAGE_RW register description

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

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

11.18 FSM_ENABLE_A (46h)

Enable FSM register (R/W)

Table 183. FSM_ENABLE_A register

FSM8_EN	FSM7_EN	FSM6_EN	FSM5_EN	FSM4_EN	FSM3_EN	FSM2_EN	FSM1_EN
---------	---------	---------	---------	---------	---------	---------	---------

Table 184. FSM_ENABLE_A register description

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

11.19 FSM_ENABLE_B (47h)

Enable FSM register (R/W)

Table 185. FSM_ENABLE_B register

FSM16_EN	FSM15_EN	FSM14_EN	FSM13_EN	FSM12_EN	FSM11_EN	FSM10_EN	FSM9_EN
----------	----------	----------	----------	----------	----------	----------	---------

Table 186. FSM_ENABLE_B register description

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

11.20 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 187. 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
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Table 188. FSM_LONG_COUNTER_L register description

FSM_LC_[7:0]	Long counter current value (LSbyte). Default value: 00000000
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Table 189. 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 190. FSM_LONG_COUNTER_H register description

FSM_LC_[15:8]	Long counter current value (MSbyte). Default value: 00000000
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11.21 FSM_LONG_COUNTER_CLEAR (4Ah)

FSM long counter reset register (R/W)

Table 191. 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 192. 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

11.22 FSM_OUTS1 (4Ch)

FSM1 output register (R)

Table 193. FSM_OUTS1 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
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Table 194. 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)

11.23 FSM_OUTS2 (4Dh)

FSM2 output register (R)

Table 195. FSM_OUTS2 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 196. 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)

11.24 FSM_OUTS3 (4Eh)

FSM3 output register (R)

Table 197. FSM_OUTS3 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 198. 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)

11.25 FSM_OUTS4 (4Fh)

FSM4 output register (R)

Table 199. FSM_OUTS4 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 200. 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)

11.26 FSM_OUTS5 (50h)

FSM5 output register (R)

Table 201. FSM_OUTS5 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 202. 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)

11.27 FSM_OUTS6 (51h)

FSM6 output register (R)

Table 203. FSM_OUTS6 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 204. 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)

11.28 FSM_OUTS7 (52h)

FSM7 output register (R)

Table 205. FSM_OUTS7 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 206. 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)

11.29 FSM_OUTS8 (53h)

FSM8 output register (R)

Table 207. FSM_OUTS8 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 208. 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)

11.30 FSM_OUTS9 (54h)

FSM9 output register (R)

Table 209. FSM_OUTS9 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 210. 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)

11.31 FSM_OUTS10 (55h)

FSM10 output register (R)

Table 211. FSM_OUTS10 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 212. 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)

11.32 FSM_OUTS11 (56h)

FSM11 output register (R)

Table 213. FSM_OUTS11 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 214. 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)

11.33 FSM_OUTS12 (57h)

FSM12 output register (R)

Table 215. FSM_OUTS12 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 216. 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)

11.34 FSM_OUTS13 (58h)

FSM13 output register (R)

Table 217. FSM_OUTS13 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 218. 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)

11.35 FSM_OUTS14 (59h)

FSM14 output register (R)

Table 219. FSM_OUTS14 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 220. 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)

11.36 FSM_OUTS15 (5Ah)

FSM15 output register (R)

Table 221. FSM_OUTS15 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 222. 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)

11.37 FSM_OUTS16 (5Bh)

FSM16 output register (R)

Table 223. FSM_OUTS16 register

P_X	N_X	P_Y	N_Y	P_Z	N_Z	P_V	N_V
-----	-----	-----	-----	-----	-----	-----	-----

Table 224. 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)

11.38 EMB_FUNC_ODR_CFG_B (5Fh)

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

Table 225. 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 226. 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)
--------------	---

11.39 EMB_FUNC_ODR_CFG_C (60h)

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

Table 227. 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 228. 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)
--------------	--

11.40 EMB_FUNC_INIT_B (67h)

Embedded functions initialization register (R/W)

Table 229. 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 230. EMB_FUNC_INIT_B register description

MLC_INIT	Machine learning core initialization request. Default value: 0
FSM_INIT	FSM initialization request. Default value: 0

11.41 MLC0_SRC (70h)

Machine learning core source register (R)

Table 231. 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 232. MLC0_SRC register description

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

11.42 MLC1_SRC (71h)

Machine learning core source register (R)

Table 233. 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 234. MLC1_SRC register description

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

11.43 MLC2_SRC (72h)

Machine learning core source register (R)

Table 235. 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 236. MLC2_SRC register description

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

11.44 MLC3_SRC (73h)

Machine learning core source register (R)

Table 237. 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 238. MLC3_SRC register description

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

11.45 MLC4_SRC (74h)

Machine learning core source register (R)

Table 239. 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 240. MLC4_SRC register description

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

11.46 MLC5_SRC (75h)

Machine learning core source register (R)

Table 241. 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 242. MLC5_SRC register description

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

11.47 MLC6_SRC (76h)

Machine learning core source register (R)

Table 243. 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 244. MLC6_SRC register description

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

11.48 MLC7_SRC (77h)

Machine learning core source register (R)

Table 245. 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 246. MLC7_SRC register description

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

12 Embedded advanced features

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

Table 247. 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	

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

Write procedure example:

Example: write value 01h in register at address 7Ch (FSM_PROGRAMS) in page 1

- Write bit FUNC_CFG_EN = 1 in FUNC_CFG_ACCESS (01h) // Enable access to embedded functions registers
- Write bit PAGE_WRITE = 1 in PAGE_RW (17h) register // Select write operation mode
- Write 0001 in PAGE_SEL[3:0] field of register PAGE_SEL (02h) // Select page 1
- Write 7Ch in PAGE_ADDR register (08h) // Set address
- Write 01h in PAGE_DATA register (09h) // Set value to be written
- Write bit PAGE_WRITE = 0 in PAGE_RW (17h) register // Write operation disabled
- 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 7Ch (FSM_PROGRAMS) in page 1

- Write bit FUNC_CFG_EN = 1 in FUNC_CFG_ACCESS (01h) // Enable access to embedded functions registers
- Write bit PAGE_READ = 1 in PAGE_RW (17h) register // Select read operation mode
- Write 0001 in PAGE_SEL[3:0] field of register PAGE_SEL (02h) // Select page 1
- Write 7Ch in PAGE_ADDR register (08h) // Set address
- Read value of PAGE_DATA register (09h) // Get register value
- Write bit PAGE_READ = 0 in PAGE_RW (17h) register // Read operation disabled
- 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 1 - Embedded advanced features registers

13.1.1 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 reaches this value, the FSM generates an interrupt.

Table 248. FSM_LC_TIMEOUT_L register

FSM_LC_TIMEOUT7	FSM_LC_TIMEOUT6	FSM_LC_TIMEOUT5	FSM_LC_TIMEOUT4	FSM_LC_TIMEOUT3	FSM_LC_TIMEOUT2	FSM_LC_TIMEOUT1	FSM_LC_TIMEOUT0
-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------

Table 249. FSM_LC_TIMEOUT_L register description

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

Table 250. FSM_LC_TIMEOUT_H register

FSM_LC_TIMEOUT15	FSM_LC_TIMEOUT14	FSM_LC_TIMEOUT13	FSM_LC_TIMEOUT12	FSM_LC_TIMEOUT11	FSM_LC_TIMEOUT10	FSM_LC_TIMEOUT9	FSM_LC_TIMEOUT8
------------------	------------------	------------------	------------------	------------------	------------------	-----------------	-----------------

Table 251. FSM_LC_TIMEOUT_H register description

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

13.1.2 FSM_PROGRAMS (7Ch)

FSM number of programs register (R/W)

Table 252. 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 253. FSM_PROGRAMS register description

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

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

FSM start address register (R/W). First available address is 0x033C.

Table 254. FSM_START_ADD_L register

FSM_START7	FSM_START6	FSM_START5	FSM_START4	FSM_START3	FSM_START2	FSM_START1	FSM_START0
------------	------------	------------	------------	------------	------------	------------	------------

Table 255. FSM_START_ADD_L register description

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

Table 256. FSM_START_ADD_H register

FSM_START15	FSM_START14	FSM_START13	FSM_START12	FSM_START11	FSM_START10	FSM_START9	FSM_START8
-------------	-------------	-------------	-------------	-------------	-------------	------------	------------

Table 257. FSM_START_ADD_H register description

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

14 Soldering information

The LGA package is compliant with the [ECOPACK](#) and RoHS standard.

It is qualified for soldering heat resistance according to JEDEC J-STD-020.

For land pattern and soldering recommendations, consult technical note [TN0018](#) available on www.st.com.

15.2 LGA-14 packing information

Figure 24. Carrier tape information for LGA-14 package

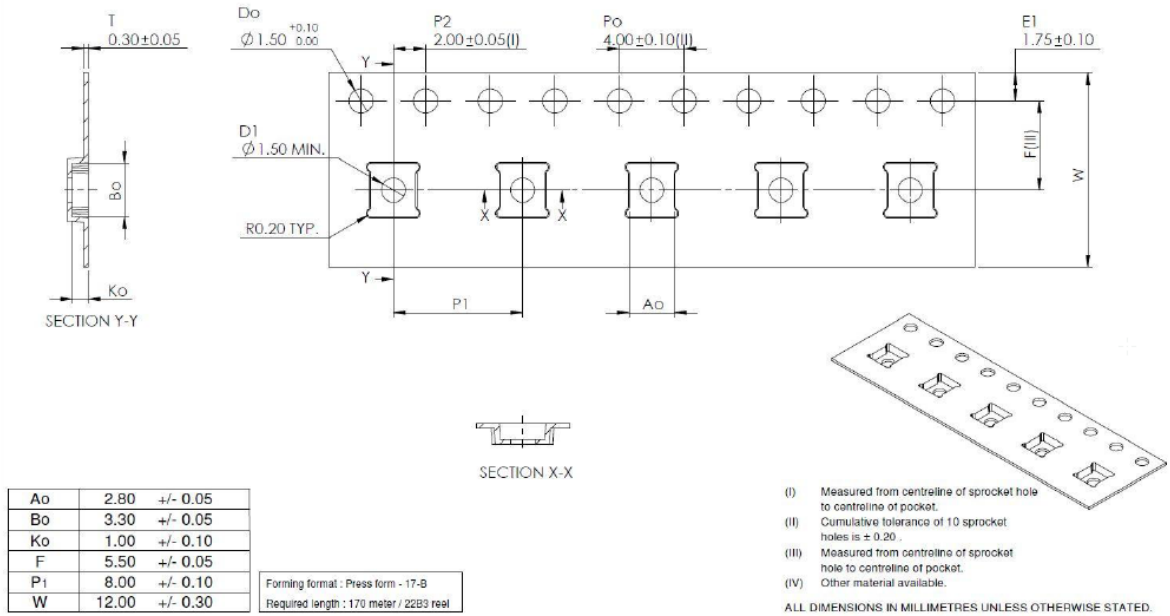


Figure 25. LGA-14 package orientation in carrier tape

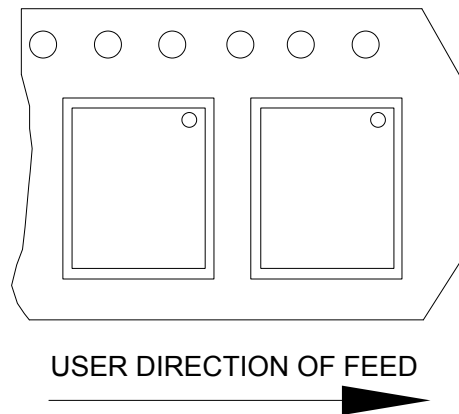


Figure 26. Reel information for carrier tape of LGA-14 package

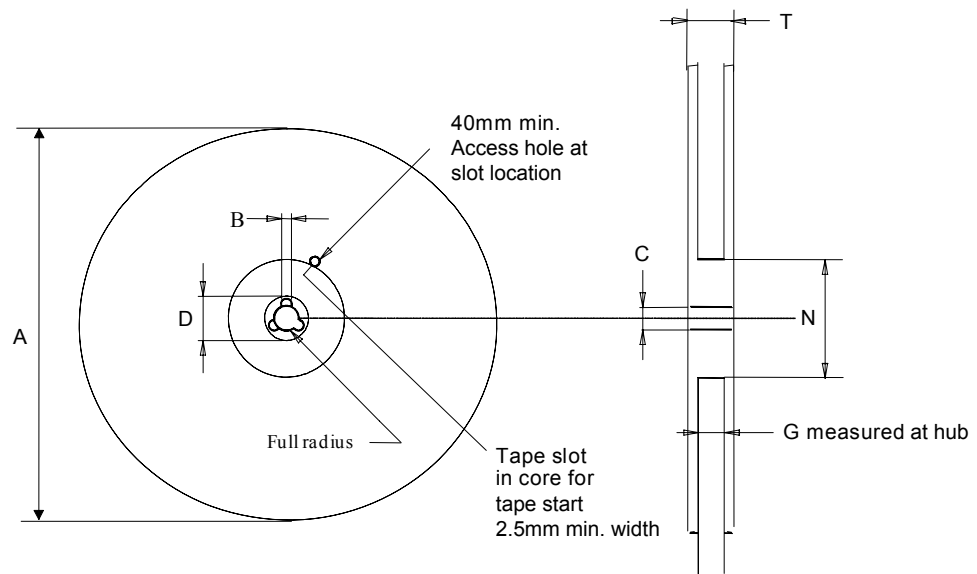


Table 258. Reel dimensions for carrier tape of LGA-14 package

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

Revision history

Table 259. Document revision history

Date	Version	Changes
12-Jan-2023	6	First public release
01-Feb-2023	7	Minor textual updates
22-May-2023	8	Updated title, Features , Description , and Product resources Updated Figure 3. Machine learning core in the ASM330LHB Updated test conditions in Table 3. Electrical characteristics

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